engineering & services

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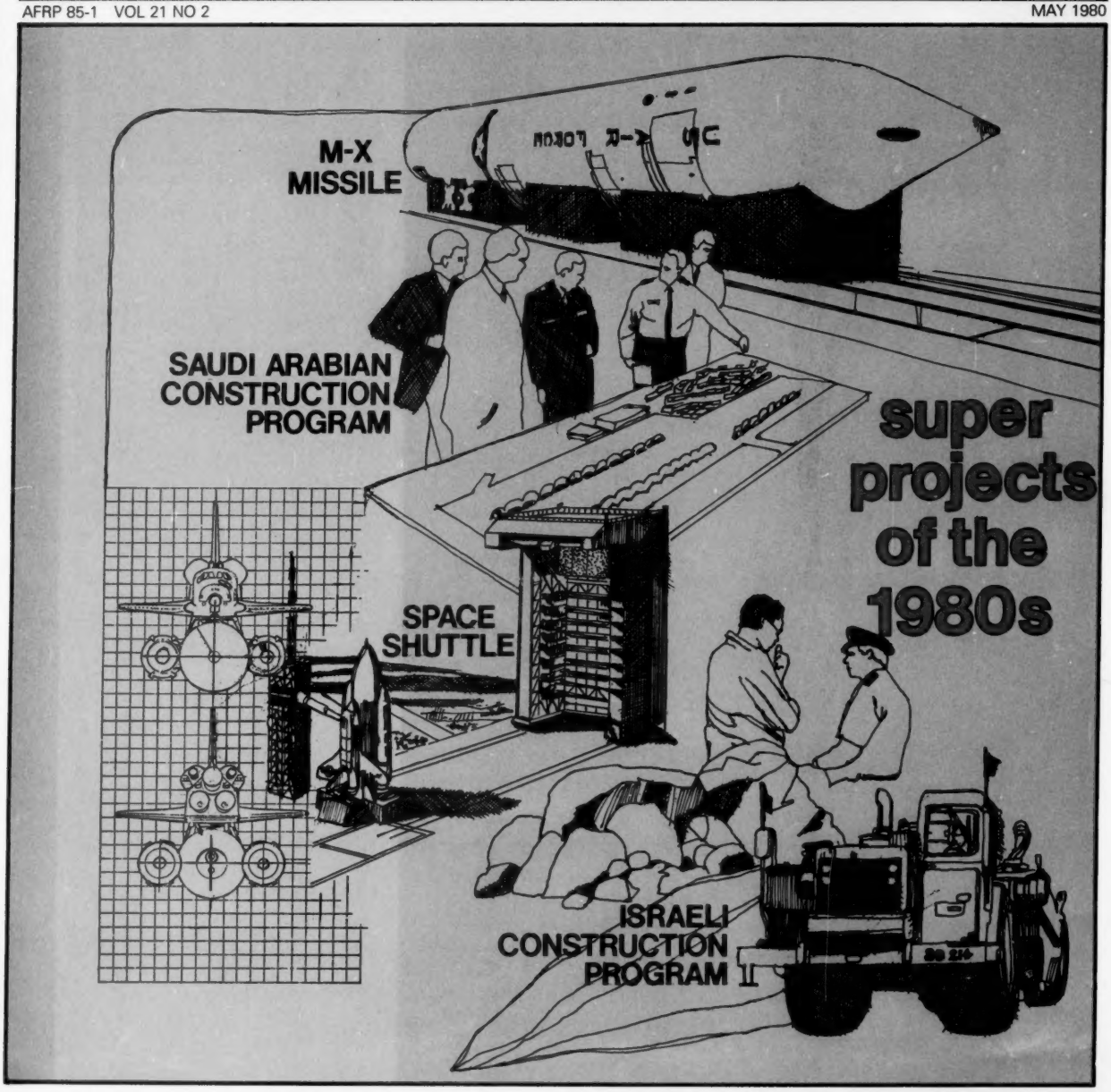
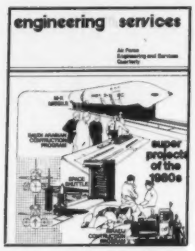


Twenty years ago, Air Force Civil Engineers provided the research, development, design, program management and construction of the ground environment facilities for the massive ICBM program. A year later, their contributions to this DOD effort were recognized when the American Society of Civil Engineers presented its coveted "Outstanding Civil Engineering Achievement of the Year" award to the Air Force for its contribution in the multi-million dollar program.

This unprecedented effort by Air Force Civil Engineers was a turning point in the proud and exemplary history of Civil Engineering contributions toward accomplishment of the Air Force mission. The inventiveness and resourcefulness of Civil Engineers in meeting a massive challenge was proven. Since that time, through intense professional work, Civil Engineers have produced successfully when called upon. In 1963, because of sensitive situations in Southeast Asia, the need for establishment of mobile engineering squadrons was advocated. In 1964, Prime BEEF was born, closely followed by the introduction of RED HORSE. In 1966, for the first time in the history of Air Force Civil Engineering, Civil Engineers managed and supervised the design and construction of a multi-million dollar air base. The accomplishments go on and on.

Now in the 1980s, Air Force Civil Engineers are on the brink of yet another historical era. Their decided role in providing the facility support for a variety of weapons systems and other massive Air Force programs, will be tested. These programs include the M-X; the Space Shuttle; Israeli and Saudi Arabian construction; the Ground and Air Launch Cruise Missiles; and the McClellan Energy Showcase.

Air Force Civil Engineers who are vitally involved in these programs have captured the immense scope of these projects in specific articles presented in this issue. Each of the articles is headed with a reproduction of the artwork that headlines this page. We hope you will enjoy reading these special reports as much as we have had a hand in putting them together.



SUPER PROJECTS — facing challenges of a scope never before dealt with in the history of Air Force Engineering and Services.

AIR FORCE
engineering & services
QUARTERLY

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The **Air Force Engineering & Services Quarterly** is an official non-directive Headquarters US Air Force publication, published quarterly under provisions of Chapter 12, AFR 5-1. Its purpose is to provide Air Force Civil Engineering and Services personnel with a timely and comprehensive picture of the importance, wide ranging involvement and direct relationship of civil engineering and services activities to successful accomplishment of the Air Force mission. It provides current information about significant civil engineering and services programs and accomplishments throughout the Air Force; pertinent developments in science engineering and management; and educational/training opportunities for enhancing professional thought and development. The **Quarterly** is edited and published by HQ Air Force Engineering and Services Center, Tyndall AFB, Florida. Contributions, suggestions and criticism are welcome. Opinions expressed do not necessarily reflect the official viewpoint of the Department of the Air Force, the Director of Engineering and Services or the editorial staff. Authority to publish this periodical automatically expires on January 1981 unless its continuance is authorized by the approving authority prior to that date.

Super Projects of the 80s

In this decade we will be facing challenges of a scope we have never dealt with in the history of the Air Force. The most important of these is M-X support for a then-year projected cost of $20,000,000,000. The others are the Space Transportation System, Israeli and Saudi Arabian Air Base Construction, Ground and Air Launch Cruise Missiles and McClellan Energy Showcase support for a total projected cost of $4,300,000,000.

These projects encompass all areas of Engineering and Services. They will require our people to be highly dedicated and motivated and exhibit an unparalled degree of professionalism. We will be building large, unique facilities as well as complete air bases which will require innovative, state-of-the-art design and construction techniques which are detailed in this issue of the **Engineering & Services Quarterly.** These projects will form not only the Air Force image, but the Engineering and Services image over the next decade. The challenge is here and we must accept it.

These facilities must be designed and built within the parameters necessary to achieve mission accomplishment, energy conservation and a living and working atmosphere conducive to outstanding performance by our Air Force people. Due to the sheer magnitude of these projects and our intimate involvement, we cannot afford to sit back and let things happen; we must be the driving force to make things happen when, where and how to meet critical deadlines. To do this will require a high regard for dollars, safety, time and people. This is our chance, once again, to illustrate not only to our peers, but to our country that we do things right.

Strict attention must be given to environmental issues such as land acquisition, water and mineral rights, clear zones and economic impacts to help the Air Force and our Government to gain and retain support for these projects so critical to national defense and international policy. We must also properly program and seek required funding to prevent unnecessary delays and insure the finished projects are usable and meet the operator's requirements. This leads into another important area of design and construction. Designs must be carefully and thoroughly thought out not only to support a particular facility, but to make that facility consistent with others. We cannot afford tunnel vision in this important area since it is necessary to build these projects as a totally integrated whole. To prevent construction delays, the designs must be near perfect to eliminate costly, both in time and dollars, change orders. Construction will be a most important key in the overall scheme and will only be as good as the design. Again, we must insure the construction techniques and materials are absolutely right for each facility and the materials are available in sufficient quality and quantity.

As you can see the Super Projects of the 80s present a real challenge to Engineering and Services. We will all be involved from the initial programming through land acquisition, design, construction, facilitizing, and operating and maintaining these facilities which range from exotic test and industrial facilities to community facilities for our people. Perhaps I have said nothing new except the magnitude of these projects is so great and of unparalleled national importance, we must all put forth an extra effort to rise to and meet this challenge of Super Projects.

William D. Gilbert

WILLIAM D. GILBERT
Major General, USAF
Director of Engineering and Services

From the Director

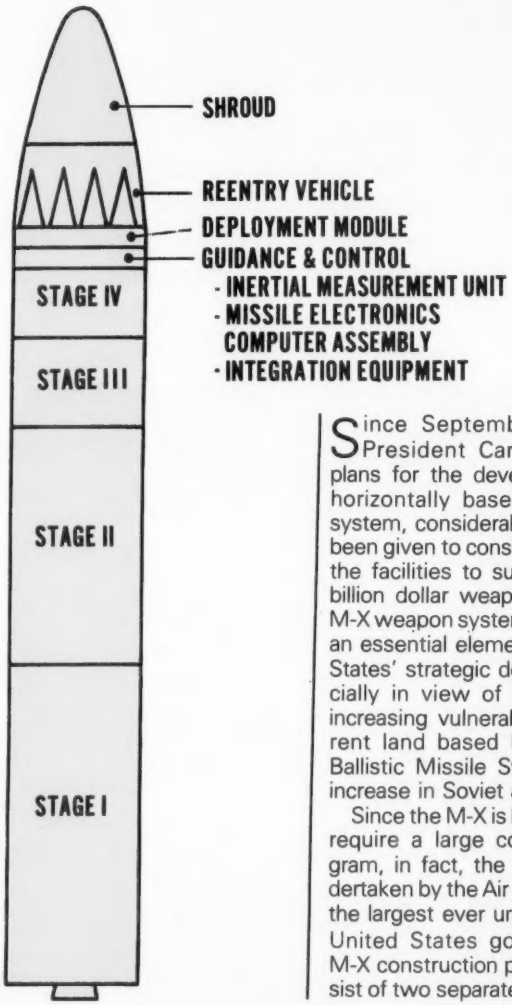
A SUPER SPECIAL PROJECT REPORT

Air Force Civil Engineers will play a vital role in bringing the nation's most advanced land based weapon system into operation. They will be responsible for one of the largest construction programs ever undertaken by the Air Force.

It is the ... **M-X Weapon System...**

an essential element of strategic deterrence

by Lt Col Thomas L. Bozarth



Since September 1979 when President Carter announced plans for the development of the horizontally based M-X weapon system, considerable attention has been given to construction plans for the facilities to support the multi-billion dollar weapon system. The M-X weapon system is described as an essential element of the United States' strategic deterrence, especially in view of the fact of the increasing vulnerability of our current land based Intercontinental Ballistic Missile Systems and the increase in Soviet adventurism.

Since the M-X is land based, it will require a large construction program, in fact, the largest ever undertaken by the Air Force and one of the largest ever undertaken by the United States government. The M-X construction program will consist of two separate packages: one, for flight test facilities at Vandenberg AFB, California, and the other, for operational facilities.

The M-X, a three stage solid propellent missile, will be test fired at Vandenberg AFB before it is operationally deployed. Testing will begin in January 1983 with three test flights to be accomplished prior to announcement of the production decision for the missile and basing in July 1983.

Facility projects costing about $87 million will be required for the test program, $57 million of which has already been authorized in the 1980 Military Construction Program (MCP). Of the remaining $30 million in construction costs for the test program, $17 million will be requested in the 1981 MCP and the final $13 million in the 1982 MCP.

Projects will include facilities for:

- **Off-loading missile stages, from rail transportation;**
- **Storing and assembling missile stages, payloads and flight instrumentation;**
- **Test shelters;**
- **Roads and utilities.**

A total of 20 test flights are planned before the July 1986 Initial Operational Capability (IOC) date for the weapon system. Once the flight test program is complete, Strategic Air Command missile crews will use the facilities for operational test and evaluation launches throughout this century.

The operational M-X weapon system will consist of 200 missiles with 4,600 horizontal shelters. One of the basing modes being considered is illustrated in **Figure 1** and

This is a full scale mockup of the new mobile M-X inter-continental ballistic missile being developed.

Figure 2. There will be one missile deployed in a closed loop roadway arrangement consisting of 23 shelters. The missile will be loaded on a Transporter - Erector - Launcher (TEL), **Figure 3,** which will be moved from one shelter to another for deception. The missile can only be fired from a TEL, and the TEL is capable of firing the missile inside or outside the shelter. The horizontal shelters will have ports that can be removed for SALT verification.

The missile and the TEL will be assembled at the Designated Assembly Area (DAA). From the DAA, the missile and the TEL are transported separately to one of the 200 clusters. There are barriers on the transportation system which must be removed and replaced in order to aid in SALT verification. At each cluster, the missile will be loaded on the TEL and, at this point, the missile becomes launch capable.

To provide the desired survivability without a greater cost for additional hardening, the minimum spacing between shelters is baselined at 7,000 feet. Although this will require a large deployment area, very little land will be withdrawn from public use. The Air Force prefers to deploy the system in the Nevada-Utah area which has a large amount of public land and a sparse population. Within this mountainous area, there are many valleys which can accommodate the 23 shelter clusters. Based on preliminary investigations, it appears that the M-X weapon system will be dispersed over 6,000 to 8,000 square miles in this area. However, only 25 square miles will be withdrawn from public use. Most areas, including roads in the clusters, will remain open to the public.

An Environmental Impact Statement (EIS) is being prepared for the deployment area selection and construction. It will also be used to support withdrawal of public lands from Department of Interior control. The EIS will be extensive since it must address issues such as grazing and mineral rights; water rights; water and air pollution; social and economic impact on local communities; ecological impact; impact on native American Heritage; and impact on the construction industry at the local, regional and national levels. An integral part of the environmental process is site selection for the shelters, designated assembly area, support areas and operating base(s). Some of the siting criteria are still under study. Although concept plans are being developed for one main operating base and one satellite installation, the Air Force is studying other options. The number of operating bases will affect the number and location of dispersed maintenance and security alert facilities required for the system.

Preparing the environmental impact statement, accomplishing land withdrawal actions, and developing facility requirements represent a substantial undertaking. As with most programs, there are tight time

constraints. In his announcement last fall, President Carter said that 10 missiles would be operationally ready in 1986 and that all 200 would be operational in 1989. To meet this commitment, the Air Force has established specific milestones for the M-X construction program:

- **Final environmental impact statement: October 1980.**
- **File land withdrawal application: November 1980.**
- **Land available for construction: November 1981.**
- **Start construction of roads, utilities and contractor support facilities: January 1982.**
- **Start construction of technical support facilities (designated assembly area, munitions storage, etc.): January 1983.**
- **Start construction of protective structures: January 1984.**

The current "best estimate" of the construction cost of the M-X Test and Operational Facilities in then-year dollars is $20 billion. In developing the cost estimate, assumptions were made concerning the composition and location of the operating system and its support system. Accordingly, the estimate will be refined as the unknowns in the program become known.

Management of this multi-billion construction program will be challenging and will require extensive coordination within and outside the Department of Defense. Therefore, an Air Force Regional Civil Engineering office has been established for field level management of the M-X construction program. The AFRCE M X has a wide range of responsibilities: development of construction plans and programs; administration of the environmental program; management of real estate actions; and management of design and construction for the Air Force. The AFRCE M X must work closely with the Ballistic Missile Office in identifying construction requirements; the Corps of Engineers in managing and directing design and construction; and the Strategic Air Command, Air Force Commissary Service, Army and Air Force Exchange Service, and the Military Personnel Center in identifying base facility requirements. In addition, AFRCE M X and BMO, along with Headquarters US Air Force and the Office of the Secretary of the Air Force, must work various issues with such non-DOD agencies as:

- Environmental Protection Agency in preparing Environmental Impact Statements;
- Department of Interior on land withdrawal procedures;
- Department of Education on schools impact;
- Department of Health and Welfare on other community issues; and
- Department of Energy on renewable energy.

Establishing the AFRCE M X was a major Air Force Civil Engineering initiative. Another initiative is developing renewable energy sources for the M-X support system to reduce dependence of fossil fuel

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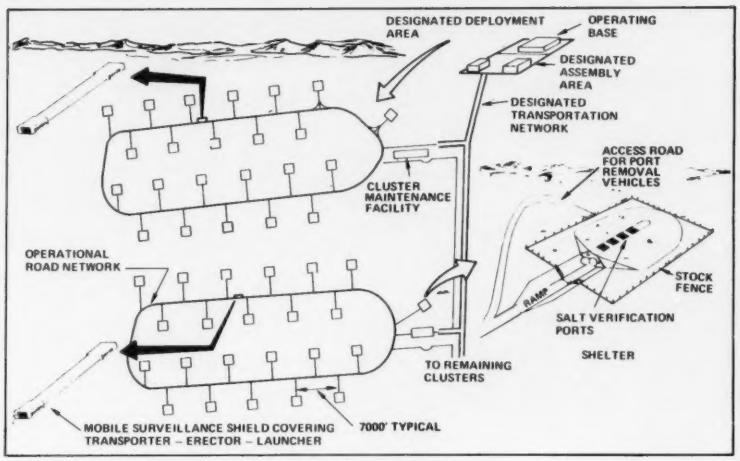
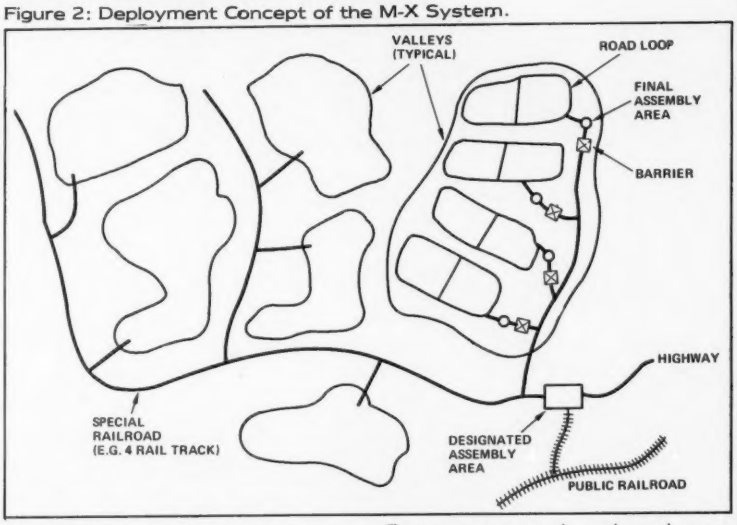


Figure 1: The Basing of the M-X System.

Figure 2: Deployment Concept of the M-X System.



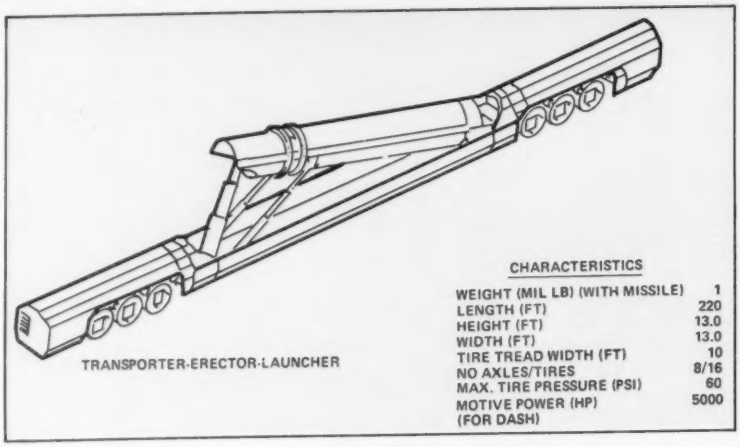


Figure 3: Transporter-Erector-Launcher (TEL) Concept.

Artist's concept of the hardened horizontal shelter for the M-X missile.

energy sources. The Nevada-Utah area offers an excellent opportunity to use solar and geothermal energy and the Air Force is actively working with the Department of Energy to develop economical and efficient solar and geothermal systems. Hopefully, the technology developed in the M-X program will make the use of solar and geothermal energy in the private sector more attractive.

The new operating base(s) offers Air Force Civil Engineers the opportunity to design and construct the most up-to-date, state-of-the-art military installation to support the unique requirements of the M-X system. As an initial step in this effort, SAC has asked architect-engineer firms to develop conceptual plans for the base(s). In coordination with other Air Force community planners, SAC has developed the following goals for the conceptual planning effort:

- **Goal 1 — Energy Awareness:** provide for conservation, renewable energy systems, energy systems, alternate sources of energy, energy efficient construction, and future energy flexibility.
- **Goal 2 — Natural/Human Environmental Awareness:** minimize air, water and noise pollution; handle/recycle waste products; and preserve the natural environment.
- **Goal 3 — Quality of Life Awareness:** provide the highest possible quality of life through convenient transportation systems, linkage with outside communities, maximum recreation/leisure activities, and well-planned and attractive facilities.
- **Goal 4 — Conceptual Land Use Awareness:** provide the most efficient/functional land use plan with the flexibility to meet future needs.
- **Goal 5 — Maintenance Awareness:** use indigenous materials, the existing environment, and appropriate planning concepts to minimize maintenance.

The current plan will provide planning criteria for follow-on comprehensive planning; guidelines for future programming; and a theme for design/architecture and construction.

Conceptual planning for new installations, establishing an AFRCE MX, preparing environmental impact statements, working on renewable energy sources, and programming test facilities are examples of how Air Force Civil Engineers are helping to bring the nation's most advanced land based weapons system into operation. It is evident that those involved in facilities programming, environmental planning, criteria development, and design and construction management will continue to play a key role in the success of the M-X weapon system. E&S

AFRCE MX established at Norton AFB

In anticipation of the unique design and construction requirements associated with the M-X Weapon System, a special Air Force Regional Civil Engineer (AFRCE MX) has been established at Norton AFB, California. Establishment of the AFRCE MX is in total support of the Ballistic Missile Office (BMO), providing the management and resources for the design and contract award phases of the M-X program. This new management organization will also manage the Air Force Environmental Planning (communities/ comprehensive, environmental protection and natural resources) and real property activities within the specified M-X geographic area as well as affected contiguous areas. It will also act as the on-site point of contact with the Army Corps of Engineers for all real property acquisition and disposal projects.

The organizational development of the AFRCE MX will provide for administrative, fiscal and program management and will also have a limited legal and procurement assistance capability. Program development and the necessary documentation to support Congressional submittal, along with the maintenance of an automated information display system, are major functions of a special programs division of the organization.

The Engineering Division has been uniquely organized in that it recognizes the differences between the technical facilities and the non-technical support facilities. It is the way in which separate and distinct design control interfaces will be coordinated with the BMO and the using agencies. For support of Environmental Planning, the organization has the capability to provide for real property acquisition and withdrawal activities. It will also address the natural resource concerns and it will continue to manage the interface with the Environmental Impact Analysis Process and the development of the Environmental Impact Statements. In addition, it will act as the overall coordinator for the development of the comprehensive plan, that is, the master plan for the entire M-X installation.

The AFRCE MX will have operating locations (OL) at Tyndall AFB, Florida, and Bolling AFB, Washington DC. These OLs will provide the operating support and program liaison to the Air Force Engineering and Services Center and the Directorate of Engineering and Services at Headquarters US Air Force. The total organization has been designed to be responsive to program needs as we see them today. As these requirements change, the organization will change. Manning will fluctuate in numbers and skills composition. As an example, the AFRCE MX at Norton AFB will grow to an authorized strength of 77 by the end of FY 1980, and continue to grow through FY 1983 reaching a maximum of 184. It then will draw down to 138 authorizations in FY 1986.

The Army Corps of Engineers, with the South Pacific Division as Lead Division, is also establishing an office at Norton AFB and will begin to staff this function in the near future. During the next few months as this new organization comes together and matures, Headquarters Strategic Air Command, AFESC, and the Central and Western AFRCEs will provide needed assistance to effectively control and monitor the numerous initiatives already in being.

The management plan of the AFRCE MX has been designed to bring together every resource available to Engineering and Services in such a way that the appropriate expertise responds to a particular need. E&S

A SUPER SPECIAL PROJECT REPORT

The engineer's view of how construction is progressing on the launch complex.

Space Shuttle Update: Into the Construction Phase

Editor's Note: "The Space Shuttle Goes West," an article by Lieutenant Colonels Raymond E. Rodgers, Jr, and Tyler Jackson in the August 1979 issue of the AIR FORCE ENGINEERING & SERVICES QUARTERLY, outlined the Air Force involvement in the Space Shuttle program. It detailed the role of Air Force Civil Engineers in planning, budgeting and designing space shuttle construction projects. This article recaps and updates the program as it enters the construction phase.

by Lt Col Thomas L. Bozarth

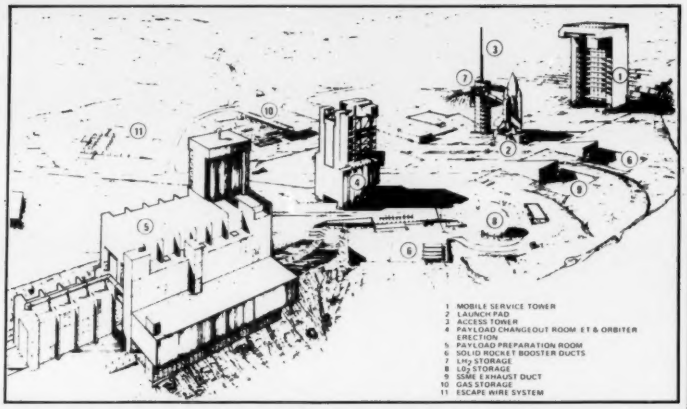
The space shuttle is a totally new concept in space shuttle operations. It is a manned, reusable vehicle which will launch like a missile, perform on-orbit operations and return to earth like a glider. The shuttle orbiter contains a cargo compartment for deploying and recovering Department of Defense (DOD) and civilian satellites. The orbiter will be propelled into space with its three main liquid-fueled engines augmented by two recoverable solid rocket boosters.

Two launch sites have been selected for the shuttle: the Kennedy Space Center, Florida, and Vandenberg AFB, California. The National Aeronautics and Space Administration (NASA) is responsible for providing all facilities at the Kennedy Space Center that will be jointly used by NASA and the DOD. The Air Force is responsible for providing all joint use facilities for the Vandenberg AFB launch site as well as unique DOD facilities at the Kennedy Space Center.

The Air Force construction program is currently estimated at about $366 million. Of this amount, $309 million is for facilities at Vandenberg AFB; $17 million is for facilities at Port Hueneme, California, for recovering the solid rocket boosters launched from Vandenberg AFB, and $30 million is for unique DOD facilities at Cape Canaveral AFS and the Kennedy Space Center. Another $9 million will be spent for modifications in the NASA mission control center at the Johnson Space Center, Texas. The Air Force facility projects at the Johnson and Kennedy Space Centers are required to provide facilities for DOD missions. The Vandenberg AFB construction program will provide a launch complex; a 7,000 foot runway extension for recovering the orbiter; shuttle maintenance and refurbishment facilities; a facility used to insert payloads into the orbiter; and logistics and administrative facilities.

In 1979 and 1980, Congress appropriated $188.2 million for the

The shuttle orbiter, after performing on-orbit operations, returns to earth like a glider.


1 MOBILE SERVICE TOWER
2 LAUNCH PAD
3 ACCESS TOWER
4 PAYLOAD CHANGEOUT ROOM ET & ORBITER ERECTION
5 PAYLOAD PREPARATION ROOM
6 SOLID ROCKET BOOSTER DUCTS
7 LH_2 STORAGE
8 LO_2 STORAGE
9 SSME EXHAUST DUCT
10 GAS STORAGE
11 ESCAPE WIRE SYSTEM

The artist's concept of the completed launch complex at Vandenberg AFB.

space shuttle construction program. The remaining $180 million will be spread over the 1981, 1982 and 1983 military construction programs. Of the $188.2 million appropriated to date, the largest amount was $118.2 million for the Vandenberg AFB launch facilities.

Launch facilities for the shuttle will be provided by modifying and adding to those facilities originally constructed for the manned orbiting laboratory program. Although the Air Force designed the launch complex, the Army Corps of Engineers (COE) has responsibility for construction management. An Air Force civil engineering office under the Air Force Systems Command Space Division has been established at Vandenberg AFB to interface with the COE during construction. Construction of the launch facilities started in 1979. Other projects will be placed under contract in early 1980.

In the 1980s, Air Force Civil Engineers will continue their deep involvement in the space shuttle program. Facility design will continue well into 1981 and construction will continue into 1985. E&S

When NASA requested assistance from the Air Force for a comprehensive evaluation of structural airfield conditions in support of the Space Shuttle Orbiter, engineers from the AFESC responded. It's an example of the type of support being provided by Air Force Civil Engineering to a program of national significance.

Project Touchdown: Lending a hand

By Maj James I. Clark

Air Force Civil Engineers recently completed a comprehensive evaluation of an unpaved landing site for the Space Shuttle Orbiter in the alkali salt flats area of the White Sands Missile Range, New Mexico. They provided assistance to the National Aeronautics and Space Administration (NASA) in the program, code named Project Touchdown. Engineers from the Air Force Engineering and Services Center (AFESC), Tyndall AFB, Florida, were totally responsible for the management of the project.

The Space Shuttle Orbiter is a main portion of NASA's reusable transport system which will reduce the cost and increase the effectiveness of using space for commercial, scientific, and defense requirements. The Orbiter is 122 feet long, 57 feet high, with a wing span of 78 feet and a gross landing weight of about 200,000 pounds. The Orbiter is ferried between locations by a Boeing 747-100 aircraft. When mated to the ferry aircraft, the combined maximum gross weight of the pair is 738,000 pounds. When fully operational, the Orbiter missions will conclude with a landing on the 15,000 foot shuttle runway at NASA Kennedy, Florida.

During testing of the unpaved landing site at the White Sands Missile Range, rut failures such as these occurred from the load cart test.

To assure success of an error-free landing at NASA Kennedy, six orbital test flight landings of the Orbiter will be conducted at Edwards AFB, California, in an area called the Rogers dry lake bed. Because the Rogers dry lake area is under water at certain times of the year, a backup landing strip for the Orbiter will be the Northrup Strip, located in the White Sands Missile Range. Although the Northrup Strip remains dry for most of the year and is under the flight path of the first earth orbit after shuttle launch, its structural capacity was unknown. Thus, the need was immediate to conduct a comprehensive evaluation of the suitability of the Northrup Strip area to support the Orbiter landings and subsequent ferrying of the Orbiter mated to the Boeing aircraft.

Site Geography/Geology

The Northrup Strip is located in the alkali flats area of the White Sands Missile Range, about 30 miles west of Holloman AFB. The alkali flats are predominately composed of gypsum deposits. The gypsum (selenite crystals) or gypsite occurs naturally in the Northrup Strip area as a one to four inch layer of loose material over a dense mantle of interlocking selenite crystals. The mantle varies from 24 to 102 inches in thickness beneath which is found the lacustrine deposits of the lake bed. The ground water table normally varies from a depth of 41 to over 150 inches. Fine layers of clay and silts were found to be present in the mantle material, in various locations over the site.

The Northrup Strip has been used as an artillery and/or bombing range over the years. Resulting craters have refilled by natural processes; however, the materials have not redeveloped their natural cohesive strength in the relatively short time available for such

action to occur. Additionally, large craters, which exist as the result of Lance Missile impacts in the area, have been previously refilled by bulldozers with subsequently low material strengths in the crater areas. During periods of a rising water table, a hydraulic head develops beneath the mantle, resulting in a phenomena termed "sandboils" which break through the mantle; eventually, when the water recedes, a local soft area is left on the mantle.

Airfield Geometrics

The Northrup Strip originally comprised an unsurfaced runway 20,000 feet long by 300 feet wide, orientated 17/35, with a mobile tower. NASA has extended the runway to 37,000 feet; constructed a second 37,000 by 300 foot unsurfaced runway, orientated 05/23; built a 6,000 foot unsurfaced tow-way; and mounted the mobile tower near the intersection of the two runways. Runway markings have been placed using an oil distributor truck which makes black markings that are highly visible on the white gypsum sand surface. The runways have been marked as 15,000 feet of operational runway, with 11,000 foot overruns on each end. This simulates the concrete runways at NASA Kennedy and Vandenberg AFB, and provides a total of 37,000 feet of structurally sound landing surface for the Orbiter, if needed. The tow-way provides a structurally sound surface for towing the Orbiter to a mating tower for remating with the Boeing 747 ferry aircraft and then for towing the mated pair back to the runway for takeoff.

Testing Program

NASA's request for assistance indicated a need to evaluate the suitability of the Northrup Strip runways, including the overruns and tow-way, to support the Orbiter landings and the subsequent ferrying of the Orbiter mated to the Boeing aircraft. The test plan developed to achieve this objective included the following test requirements: control surveys; runway roughness evaluation (LASER profilometer); mobile drill auger holes; test pits; California bearing ratios (CBRs); proofrolling of the surface (load cart); horizontal tow force determinations; test section (multiple passes of load cart); and laboratory tests (engineering/chemical properties).

Due to NASA's urgent need for the findings, conclusions and recommendations from the test program, it was agreed that every possible attempt would be made to complete the project within 90 days. It was obvious from the start that such time constraints would require the concentrated capabilities of the total Pavements Division of the AFESC. Also, much of the field and laboratory testing would have to be conducted concurrently. The surveying crew deployed to the Northrup Strip in early April 1979 to accomplish the surveys that would be used to control all other field work. The Pavements Division surveying crew was augmented with technicians from two RED HORSE squadrons, the 820th CES and the 823rd CES, and the 49th CES from Holloman AFB.

Approximately two weeks later, the several Pavements Division field teams deployed to the site to begin all of the other field testing. The LASER profilometer team was augmented with an instrumentation technician from AFESC's Research and Development Directorate.

Materials field testing included auger holes with the mobile drill to determine material types, depths, moisture contents, and locations of the ground water table; five test pits to develop CBRs and materials densities at various depths and to obtain bulk materials samples to use in laboratory testing; CBR tests on the runway surface and underlying mantle material to determine structural strength for Boeing 747 operations evaluation; and moisture-density measurements with a nuclear measuring device to ascertain uniformity of surface materials.

The possible presence of surface irregularities, which could result in operational roughness problems, was evaluated with the LASER profilometer. This instrument measures surface elevations to the nearest one thousandth of a foot at six inch horizontal increments along a preset longitudinal line on the runway. The data

Test carts were loaded at 107,200 pounds total weight to test the gypsum mantle at White Sands Missile Range.

resulting from this evaluation were then analyzed by computer simulation of the Orbiter operating along the measured profile. Three profiles, each 37,000 feet long, were developed for each runway.

The final test requirement, and possibly the most critical, involved proofrolling the full length and width of both runways with a load cart and then evaluating multiple passes of the load cart over a specially constructed test section. The load cart was a uniquely manufactured NASA trailer with an aircraft gear simulating the Orbiter. The gear was comprised of two Boeing 707 tires mounted at 36 inches on center and inflated to 315 pounds per square inch. A total loading of 107,000 pounds was applied to the gear by loading the cart with

A mobile drill augers to determine the depth of the mantle and water table.

lead ingots. The cart was towed on the runway surface to simulate the Orbiter gear loading on the runway.

The structural testing of the surface and mantle materials with the load cart simulating the Orbiter occupied the critical path for the entire project. Unable to obtain actual Orbiter wheels and tires, as they are an extremely rare and valuable commodity, the load cart was mounted with the Boeing 707 wheels and tires which were rated at considerably less than the imposed loads and tire pressures. Consequently, heat build-up in the tires and overloading the wheels resulted in a series of spectacular tire explosions and wheel failures. The technicians became instant "experts" in tire changing and temperature control for the wheels. In spite of these obstacles, the field testing was completed and about 500 miles of load cart test lines were finished, including testing in the special test section where 10 repetitions of loading were accomplished.

While field testing was in progress, laboratory testing of the gypsum material was accomplished including materials classification, chemical analysis, engineering properties determination, and evaluation of various possible methods to stabilize the surface material over the mantle.

During testing, the intense heat at the Range caused spectacular tire blowouts.

Interim Conclusions

Numerous areas of weak surface and mantle conditions were discovered which appeared to be the result of cratering and/or sandboils. Some surface areas on the runways failed under the imposed loading from the load cart indicating inadequate compaction or nonsuitable materials in the thin fill areas over the mantle material. NASA is now in the process of reconstructing these areas, and further testing must be accomplished before the runways can be certified for use by the Orbiter. It is anticipated that, in the final analysis, the runways at Northrup Strip will be capable of accepting landings by the Orbiter and its support Boeing 747 aircraft.

Project Touchdown has been one of the most comprehensive and critically important airfield evaluation studies accomplished by the AFESC. Expeditious completion of critical and technically complex testing under difficult field conditions has resulted in a complete analysis of all structural airfield conditions that would affect Orbiter operations at the Northrup air strip. The AFESC has contributed significantly to a major program of national significance. Each team member associated with Project Touchdown has the personal satisfaction of another important job well done. E&S

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A SUPER SPECIAL PROJECT REPORT

As a provision of the Egyptian and Israeli peace treaty of 1979, the United States agreed to construct two new air bases in the Negev Desert to replace two Israeli bases in the Sinai. Here's a special report on the role of Air Force Civil Engineers and other DOD and Israeli partners in working together to achieve ultimate success in this massive effort.

Israeli Air Base Construction Program

by Capt Karsten H. Rothenberg, PE

Editor's Note: Egypt and Israel concluded a peace treaty on 26 March 1979 which was ratified by both governments on 26 April 1979. One provision of the treaty called for Israel to withdraw from the Sinai Desert within three years of ratification (by 25 April 1982). The total withdrawal of the Israel Defense Force (IDF), plus relocation of civilians from the Sinai is a herculean task to accomplish in three short years. To carry out this provision and preserve Israel's security, the United States agreed to assist in the withdrawal effort, and consequently agreed to construct two new air bases in the Negev Desert to replace two major tactical air bases in the Sinai; Israel would accomplish the balance of the relocation effort with US fiscal assistance.

Secretary of the Army, Clifford Alexander, left, Brig Gen Moshe Bar-Tov, center, and Brig Gen Paul Hartung observe construction at the Ovda site.

Anticipating a peace treaty, the Assistant Secretary of Defense for International Security Affairs dispatched a Department of Defense (DOD) Survey Team to Israel in November 1978. The team, consisting of Air Force and Army construction experts, was tasked to study the feasibility of building air bases in the Negev Desert. It concluded that two new air bases could be built in the required time frame by using "Fast-Track" design and construction procedures. In "Fast-Track", time is a major controlling factor. Design and construction time is compressed by allowing construction to start before design is complete. Once construction begins, "Fast-Track" demands that design, procurement and construction advance concurrently. The design effort is totally integrated with both procurement and construction need dates.

The survey team's findings and recommendations formed the basis for government-to-government agreements between the US and Israel for constructing air bases. Negotiated in Israel during March 1979 by a second DOD team, the agreements defined responsibilities for program development and stipulated that the US would assist with $800 million in defense articles and services; the remainder of the expected billion dollar price tag is to be borne by Israel. To avoid an adverse impact on the economy of the country, as was assessed in March 1979, the Government of Israel (GOI) determined that the US should assume responsibility for the construction effort using labor, equipment and materials procured primarily from sources outside of Israel. The government-to-government agreements state that in particular cases, to be agreed upon between the agencies, DOD and its contractors will use Israeli sources.

The Plan of Work

A third DOD team was sent to Israel in May 1979 to develop a comprehensive plan of work in conjunction with the Israeli Ministry of Defense (MOD). This team was composed of Air Force and Army personnel who possessed engineering, construction, aircraft maintenance, aircraft operations, communications, resource management and legal specialties. MOD counterparts fully participated in this joint effort. The Plan of Work assigned tasks in accordance with the government-to-government agreements and defined the scope of work, procedures to be followed, a critical path method (CPM) network analysis schedule and a detailed program budget estimate to construct two tactical fighter bases: one at Ramon, near Beersheva, and the other at Odva, near Eilat.

Program Objective

To transfer Israeli Air Force (IAF) capabilities at Etzion AB and Eitam AB in the Sinai to Ovda AB and Ramon AB in the Negev by 25 April 1982 within the budget constraints imposed by the US Government and the Government of Israel.

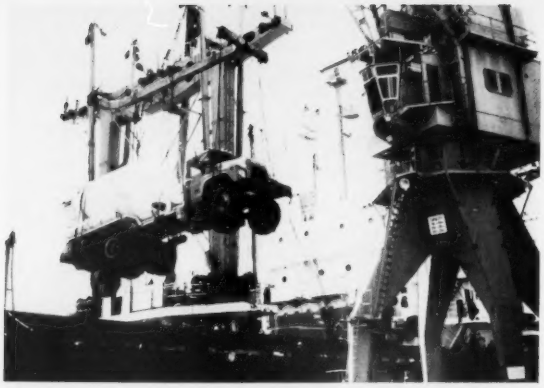
Heavy equipment rumbles through mountainous terrain on its way to the Ovda site.

The DOD and MOD were the agencies designated to implement the agreements. The DOD identified the Air Force as the executive agent for the Program. Brig Gen Paul T. Hartung was named the DOD Program Manager and the single responsible official with the authority and responsibility to facilitate cooperation with the MOD in carrying out the agreements, providing necessary liaison and promoting the swift resolution of any differences which may arise. Brig Gen Moshe Bar-Tov, the MOD counterpart, has corresponding authority and responsibility on behalf of the GOI. The Program Managers share responsibility for insuring the orderly transfer of the IAF operational capabilities at Etzion AB and Eitam AB in the Siani to Ovda AB and Ramon AB in the Negev Desert by 25 April 1982 without degrading the defense capability of the IAF. The US Army Corps of Engineers (COE) was designated as the construction agency.

Project Objective

To design and construct facilities for Ovda AB and Ramon AB as defined in the Plan of Work to meet the Program Objective within the time and cost constraints imposed by the two governments.

The COE established the Near East Project Office (NEPO) within the North Atlantic Division to manage the construction portion of the Program. It awarded three primary cost, plus fixed fee contracts to US firms. Management Support Associates (MSA), a joint venture sponsored by Lester B. Knight and Associates, Inc. of Chicago, will provide management assistance, technical support and life support assistance to NEPO. Negev Air Base Constructors (NAC), a joint venture sponsored by Perini Corporation of Framingham, Massachusetts, will design and construct the Ovda AB. Air Base Constructors (ABC), a joint venture sponsored by Guy F. Atkinson Company of San Francisco, will design and construct the Ramon AB. A total work force of approximately 4,000 is expected to be employed on the two project sites and at the Tel Aviv Headquarters.



Heavy equipment is unloaded from a ship at the Port of Eilat.

Map of Israel and Sinai Peninsula shows the location of the new bases in the Negev Desert.

Scope of Construction

The scope of construction provides for all runways, taxiways and aircraft aprons; aircraft shelters; operational, maintenance, administrative and personnel support facilities; electrical, water, waste water, and POL systems; roads; and ground improvements required to support the missions of fighter aircraft squadrons and air defense control and helicopter units that will be located at Ovda AB and Ramon AB. According to the Plan of Work, the GOI would furnish all utilities to the construction sites. Approximately 70 percent of the scope of work for vertical construction will duplicate facilities constructed at the Sinai bases, requiring only site adaption of as-built designs. The remaining scope is being designed by Israeli AE firms under the direction of the MOD and the NEPO contractors. The design and construction contractors (DCCs) are responsibile for site adaption of most of the designs. Certain elements must be fully constructed by 25 April 1982 to insure an initial operational capability (IOC) requiring full operation of all aircraft transferred from the Sinai. To permit orderly site activation, construction of many of the IOC elements must be essentially complete to allow joint occupancy as soon as possible, but no later than October 1981. The DCCs have an additional year, until 25 April 1983, to complete all non IOC elements and wrap up their projects.

The Construction Sites

The physical appearance and geology of the construction sites are a study in contrast. Both sites are located in remote parts of the mountainous Negev Desert where wind blown silt is the predominant soil type. Intense heat and dust combine to create a harsh environment during the long summer months. The relatively short winter period provides an improved construction environment. The Ovda AB is being built in a wadi or gully, necessitating construction of an extensive flood control structure for the infrequent but anticipated flash flooding. Also, there are special foundation considerations for heavy structures due to the considerable depth of silt. Ramon AB, on the other hand, is located on a rocky plateau necessitating removal of considerable quantities of rock as part of general excavation.

Current Status

With the "Fast-Track" approach to design and construction, activities are moving extremely fast. Letter contracts were signed with the three contractors by mid May 1979. Before contracts were definitized, the contractors started procuring heavy equipment, mobilization facilities and other materials. People were being hired in the US, the United Kingdom, Thailand, and Portugal. By July 1979, significant numbers of management personnel were in place in Tel Aviv and a few at each construction site. Equipment and material deliveries began arriving on schedule through the ports of Eilat and Ashdod in August 1979. UK and Thai craftsmen also began arriving at the Ramon AB site. Concurrently, the GOI was completing infrastructure support work to the sites; access roads, water supply and electrical power were provided in record time. With just over a year into the program, construction is well

under way; rock quaries have been developed; most of the major excavation has been completed; and both horizontal and vertical construction is in progress.

Problems and Solutions

The feasibility study concluded that the Israeli economy and construction industry did not have the capability to absorb the entire Sinai withdrawal program on the compressed schedule required by the Treaty. As a consequence, the GOI asked the US to construct the air bases using equipment, materials and labor procured outside of Israel and the GOI would accomplish the balance of the effort from internal resources. Since then, the general decline in the world economic picture has had its impact on Israel and political situations in the Middle East have changed considerably. Israel is beginning to see some unemployment and idle industrial capacity. With this economic change, the program shifted gears to incorporate more Israeli labor and materials into the projects than was originally planned. The Program Managers are continually studying ways to accomplish this without adversely affecting the time and cost constraints imposed for the Program. Because Israeli and third country craftsmen fall under different employment practices and wage scales as well as speak different languages, mixing the labor force may create some interesting complications requiring some diplomatic, as well as engineering and management expertise to keep construction operations on a level course. International competitive procurement of materials and equipment has resulted in considerable local sourcing which helps solve the overall problem at no additional cost to the program, and in many cases, at significant savings.

The Air Force Role

The nine man US Air Force element, along with their MOD Program Management Office counterpart, functions as the focal point for this truly unique undertaking. The small Air Force team possesses expertise in almost every facet of Air Force Civil Engineering and meets a variety of job requirements which demand imagination, adaptability and strong decision-making abilities. A key member of this team is the assigned rated officer who manages the critical areas of aircraft operations and maintenance, and provides technical advice in developing the site activation plan.

Quite naturally, the team's initial workload revolved around organizational and coordination matters because it was readily evident that the myriad of agencies associated with this program would pose significant control problems. Numerous operating procedures had to be established to delineate specific responsibilities and to facilitate the timely and effective flow of information on every subject relating to the program. From the very beginning, the Air Force Program Office began to evolve into a limited Air Force Regional Civil Engineer (AFRCE). This evolution has continued, and with the Israeli Architect/Engineers, Israeli Air Force Engineers, and MOD functional directors, the AFRCE organization has now become fully operational. This rather unique AFRCE — with manning from both governments — has greatly facilitated relationships with the COE since it is familiar with the workings of an AFRCE, and the consolidation of functions has increased overall program management effectiveness.

The AFRCE staff is presently concentrating its efforts on configuration control and working closely with the users and construction agency to shape requirements into a constructable package which will withstand evolution and refinement with minimum change. Each member of the AFRCE staff maintains daily contact with IAF users, Israeli AEs, the COE and contractor personnel in reviewing designs and master plans, evaluating engineering change proposals and monitoring construction progress. This same group is also continuing to act as the focal point for the resolution of problems involving transportation, customs, government permits, security and communications frequently associated with projects of this magnitude in foreign environments. To stretch available funds, the AFRCE team has obtained support for several value engineering approaches and is working with the IAF to retrograde equipment from the Sinai bases to the maximum extent practicable.

The dedicated and professional efforts of the assigned AFRCE members are essential to the ultimate success of this massive program. The long hours and extremely demanding work are more than adequately compensated by the innovative and exciting nature of the job. The importance of the Israeli Air Base Construction Program demands excellence and both Air Force Civil Engineers and their MOD/IAF partners are most certainly proving equal to the task. E&S

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Current Emphasis

a brief commentary on significant developments

RUNWAY FOAMING--Effective 1 July, runway foaming will be discontinued at all Air Force bases except seven vital to Military Airlift Command missions. Savings will be about $600,000 annually on foam costs. (AFESC/DEF, 970-6149).

INTERN-ARCHITECT DEVELOPMENT PROGRAM--On 20 February 1980, Brig Gen Wright, Air Force Deputy Director of Engineering and Services, and Samuel Balen, Executive Director, National Council of Architectural Registration Boards, signed a Memorandum of Understanding which officially recognizes and implements the Air Force Intern-Architect Development Program. Details of the program will be explained in an article in the August issue.

HAZARDOUS WASTE MANAGEMENT--The US EPA published final regulations during April which require reporting to EPA of hazardous waste generated, permitting of storage and disposal facilities, and implementation of a manifest system to track waste from point of generation to ultimate disposal. AFESC/DEV has established a telephone response system to respond to any technical questions on regulatory compliance. The number is AUTOVON 970-6193. (AFESC/DEV, 970-6193).

CONUS BCE CIVILIAN RECOVERY PLAN--A plan is under development to posture the BCE civilian work force to accomplish indirect combat support tasks at CONUS bases during wartime. It defines minimum wartime CONUS recovery tasks to be accomplished by the civilian force for a period up to 180 days, and establishes the number of people required to perform the tasks. Elimination or deferral of low priority work for the duration of contingencies is envisioned. (AFESC/DEOP).

BEEF REDUCTION PROGRAM--To assist in meeting the goal of reducing inflation and consumption of high cost/scarce food items, the 1980 USAF Worldwide Menu and Recapitulation of Menu Issues for USAF Worldwide Menu, AFPs 146-17 and 16, were developed to include a 25% beef reduction. Therefore, changes should be made only after considering the impact on the 25% reduction objective. All beef items must be procured from the commissary troop support activity and DPSC; use of resale beef items is not authorized (except by the installations with written authorized exemptions from HQ AFESC/DEHF). (AFESC/DEHF, 970-6215).

RAPID RUNWAY REPAIR--Interim methods to repair small craters (under 20 feet diameter) and strafing damage in pavement have been developed by AFESC. The crushed limestone repair method, intended principally for small craters, will also be an alternate method for large craters. These techniques will be validated in an Operational Test and Evaluation at North Field, South Carolina, in August 1980. An annex to AFR 93-2 will then be published about June 1981. (AFESC/RDCR).

A LA CARTE SYSTEM IMPLEMENTATION--As of February 1980, 42 bases have implemented the A La Carte System; 28 additional bases are scheduled this year. This is a continuing step toward the goal to achieve all BAS/ALACS throughout the Air Force. (AFESC/DEHF, 970-6225).

CORRECTION--The Current Emphasis item on page 12 of the February 1980 issue of the Quarterly incorrectly referred to AFR 440-24, War Reserve Policy. Correct reference is AFR 400-24, War Reserve Materiel Policy. (AF/LEEP).

18 Receive Awards for Excellence

In what perhaps was the largest presentation ceremony ever to occur in the history of Air Force Engineering and Services, 13 individuals and five Air Force installations were cited for professional excellence during 1979 at Bolling AFB, DC in February. The occasion was the 18th Annual Air Force Engineering and Services Luncheon held in observance of National Engineers Week.

Approximately 275 persons witnessed the presentations of various awards to Engineers and Services personnel. Each of the winners was cited for his remarkable technical knowledge and achievements in the areas of effective resource management and leadership. Maj Gen William D. Gilbert, Director of Engineering and Services, hosted the affair.

Air Force Civil Engineers who were recognized include:

- **2nd Lt Ronald J. Lockhart,** 4392nd Civil Engineering Squadron (CES), Vandenberg AFB, California: Meritorious Achievement Award (military).
- **Richard K. Steele,** 2852nd CES, McClellan AFB, California: Meritorious Achievement Award (civilian).
- **Nicholas F. Renzi,** 24th CES, Howard AFB, Panama: Civilian Manager of the Year (above GS-11).
- **Robert L. Bailey,** 27th CES, Cannon AFB, New Mexico: Civilian Manager of the Year (up to GS-11).
- **SMSgt James H. Doran,** 1945th CES, Rhein Main AB, Germany: NCO of the Year (MSgt-CMSgt).
- **TSgt James L. Webb,** 1605th CES, Lajes Field Azores: NCO of the Year (Sgt-TSgt).

The following three awards are sponsored by the Society of American Military Engineers and honor members of Air Force Civil Engineering for various achievements:

- **Col Melvin G. Alkire,** DSC/Engineering and Services, Headquarters Air Training Command, Randolph AFB, Texas: Newman Medal, which honors an individual for his contribution to military engineering through achievement in design, construction, administration or research and development.
- **MSgt Aaron T. Durr,** 76th CES, Andrews AFB, Maryland: Goddard Medal, for outstanding contribution to military troop construction and/or base maintenance.

CIVILIAN MANAGER (GS-11 & Above)
Nicholas Renzi — Maj Gen Gilbert

CIVILIAN MANAGER (Up to GS-11)
Robert Bailey — Maj Gen Gilbert

NEWMAN MEDAL
Col Gary Alkire — Maj Gen Gilbert

GODDARD MEDAL
MSgt Aaron Durr — Maj Gen Gilbert

SENIOR SERVICES MANAGER OF YEAR
Ronald Sonnier — Maj Gen Gilbert

SERVICES MANAGER OF YEAR
Capt J.P. Blanco — Maj Gen Gilbert

BORDNER AWARD-CATEGORY I-HEAT PLANT
Mill Valley AFS, California
Col Goodwin — Maj Gen Gilbert

BORDNER AWARD-Category II-HEAT PLANT
Maxwell AFB, Alabama
Col Gary Alkire — Maj Gen Gilbert

MERITORIOUS ACHIEVEMENT (Military)
Lt R.J. Lockhart Maj Gen Gilbert

MERITORIOUS ACHIEVEMENT (Civilian)
Richard Steele Maj Gen Gilbert

NCO OF YEAR (MSgt-CMSgt)
SMSgt Doran Maj Gen Gilbert

NCO OF YEAR (Sgt-TSgt)
TSgt James Webb Maj Gen Gilbert

CURTIN PLAQUE
Col Morrison Maj Gen Gilbert

MAJ GEN A.M. MINTON AWARD
Prof Rich Johnson John Loosbrock

SERVICES SUPERINTENDENT OF YEAR
MSgt Joel McCarty Maj Gen Gilbert

SERVICES TECHNICIAN OF YEAR
TSgt John Lucey Maj Gen Gilbert

BORDNER AWARD-CATEGORY
I-GENERATING PLANT
SMSgt Doran Maj Gen Gilbert

BORDNER AWARD-CATEGORY
II-GENERATING PLANT
5th Defense Space Comm Squadron
Col Morrison Maj Gen Gilbert

• **100th CES Beale AFB, California:** Curtin Plaque, for outstanding achievement in mission accomplishment, managerial improvements and economic use of resources.

The Aerospace Education Foundation of the Air Force Association annually presents the Maj Gen A.M. Minton Award to the best author of an article published in the **Air Force Engineering & Services Quarterly** during the last calendar year. The 1979 winner is:

• **Professor Rich Johnson,** School of Civil Engineering, Air Force Institute of Technology, Wright-Patterson AFB, Ohio. He was cited for his article "Perceptions: Believing Is Seeing" which appeared in the February issue.

Service personnel who were honored include:

• **Ronald J. Sonnier,** 3201st Air Base Group, Eglin AFB, Florida: Senior Services Manager of the Year.

• **Capt James P. Blanco,** 52nd Tactical Fighter Wing, Spangdahlem AB, Germany: Services Manager of the Year.

• **MSgt Joel McCarty,**. Eastern United Kingdom, Air Force Commissary Service: Services Superintendent of the Year.

• **TSgt John A. Lucey,** 340th Services Squadron, Malmstrom AFB, Montana: Services Technician of the Year.

The following installations were the recipients of the annual William H. Bordner Awards which honor the outstanding prime electrical and heating plants in the Air Force:

• **Mill Valley AFS, California.** (Tactical Air Command): Category I, heating plant with an installed capacity of 3.5 to 14 million BTU/hr.

• **Maxwell AFB, Alabama,** (Air Training Command): Category II, heating plant with an installed capacity over 14 million BTU/hr.

• **Det 25, 2187th Communications Group, Monte Limbrara, Italy,** (Air Force Communications Command): Category I, prime electrical generating plant with an installed capacity from 100 to 2,000 KW.

• **5th Defense Space Communications Squadron, Woomera, South Australia,** (Strategic Air Command): Category II, prime electrical generating plant with an installed capacity over 2,000 KW. E&S

A SUPER SPECIAL PROJECT REPORT

THE SAUDI ARABIAN CONSTRUCTION PROGRAM

The Kingdom of Saudi Arabia is currently engaged in an extensive modernization and industrialization program to upgrade its armed forces. Here's the report on the unique opportunity in which Air Force Civil Engineers are proving their professional excellence in managing a multi-billion dollar construction program.

by Lt Col Harry W. Glaze, PE, and Lt Col Larry G. Garrison, RA

Bridging the oceans with "team work" involves good communications, coordination and special management actions. All of these have proven to be significant factors in handling the multi-billion dollar Foreign Military Sales (FMS) Construction Programs managed by Headquarters Air Force Logistics Command (AFLC)/Engineering and Services for the Royal Saudi Air Force (RSFA).

Brig Gen Charles Lamb, program manager (third from left), reviews the mass model of the construction project prior to presenting concept designs to the Royal Saudi Air Force.

The Kingdom of Saudi Arabia is a country slightly larger than the state of Alaska and is strategically located near the hub of the Middle East. It is presently engaged in an extensive modernization and industrialization program to offset the impact of eventual depletion of its prime natural resource — oil. An essential part of the Saudi program is the upgrading of the country's armed forces to achieve military self-sufficiency. Since this effort enhances the national interests of the United States and its global commitments, the United States Government has agreed to assist the Government of Saudi Arabia in the achievement of this goal.

The United States Air Force's portion of this massive effort includes equipping the RSAF with F-5 aircraft and one of our most modern weapons systems, the F-15 Eagle. How does this directly involve the Engineering and Services community? As any Air Force Civil Engineer knows, you can't introduce modern weapon systems into vintage 1950 air bases without an extensive facility modernization program.

Construction in Saudi Arabia historically has been accomplished by the US Army Corps of Engineers

(COE). Of the approximate $30 billion in Foreign Military Sales agreements to date, approximately $14 billion has been for construction which has been managed by the COE. The Air Force and Headquarters AFLC Engineering and Services have been, or are responsible for, managing the design and construction of facilities valued in excess of $2 billion.

As the Air Force became involved in construction for the Saudi Arabian government, a whole new dictionary of nomenclature began to emerge. New words, acronyms and terms quickly became a part of the everyday vocabulary of personnel working the area of Foreign Military Sales. Examples include the word "case" which was used to describe the sale of goods or services to a foreign government; the acronym "LOA" (Letter of Offer and Acceptance) which was used to describe the country-to-country agreement to consummate a sale; and the term "surcharge funds" which were paid by foreign governments to cover the US Government overhead costs of handling "cases." It was a new ballgame with new rules and very little precedent upon which to draw.

US Air Force support of the RSAF started in the early 1970s with the initial sale of a few F-5 aircraft in programs dubbed Peace Hawk. By 1975, the sale of larger numbers of aircraft made apparent the need for a massive facility construction program. Since the US Air Force was responsible for managing the "cases" for the sale of the aircraft, maintenance, pilot training, supply support and support services for contractor personnel, the Deputy Secretary of Defense in June 1975 directed the US Air Force to act as a single manager for Peace Hawk V construction, with a designated sole-source contractor, the Northrop Corporation.

From the very beginning, unconventional approaches were necessary. The required facilities were comprised of all categories: operations, maintenance, training, administration, housing, community facilities, support services, communications and support utilities. The first facilities were needed by August 1977, and all facilities would have to be completed by February 1979. At the time of the Deputy Secretary of Defense's June 1975 decision, it was readily apparent that the majority of the facilities would have to be constructed from 12 to 18 months faster than possible, using the conventional procedures normally followed by Department of Defense agencies.

FACILITY	NUMBER
Operations	17
Training	12
Maintenance	30
Supply	8
Administrative	7
Personnel	3
Utilities	5
TOTAL	82

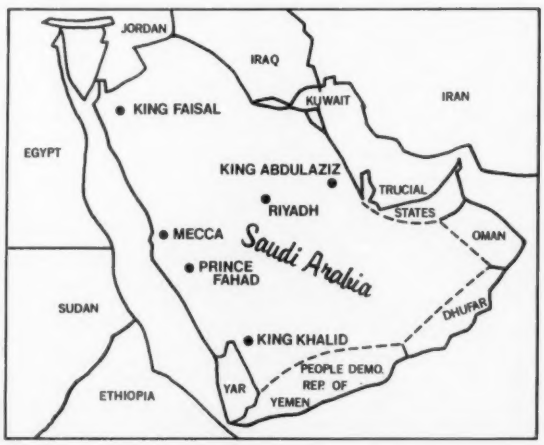
PEACE HAWK V: Technical Facilities.

The process began with the US Air Force putting together its organization, while Northrop concurrently began selecting its team. The Architect-Engineer (A-E) firm of Daniel, Mann, Johnson, and Mendenhall, and the construction management firm George A. Fuller, were selected, and joint offices were established in Los Angeles, California. The US Air Force established one management office within Headquarters AFLC DCS/Engineering and Services and a second organization in Saudi Arabia with a staff of six engineers. Four of the engineers, three of which would eventually become the resident engineers at the RSAF bases, were initially assigned to the contractor's design office in Los Angeles to provide over-the-shoulder design reviews and expedite design decisions. As designs were completed, these engineers were phased into Saudi Arabia to assume duties as resident engineers. The first engineer reported to the design offices in the last week in September 1975, just as the contractor was moving in his furniture.

When designs were starting, project books were developed and presented to the RSAF for approval. These same project books were used as the basis for bids during an international bidder's conference. After it was held, bids were received and final design documents were later provided. Although this procedure resulted in numerous field problems, it enabled construction to start some three to four months earlier than normal operations would have allowed.

Three years later, the RSAF — after taking aircraft deliveries as scheduled, successfully overcoming all kinds of construction problems, and ending up with the finest aircraft maintenance facilities in the world — presented the US Air Force its biggest challenge: facility support for the F-15 Eagle.

Air Force Civil Engineers are managing the design and construction of over $2 billion in the Kingdom of Saudi Arabia, a country slightly larger than the state of Alaska.



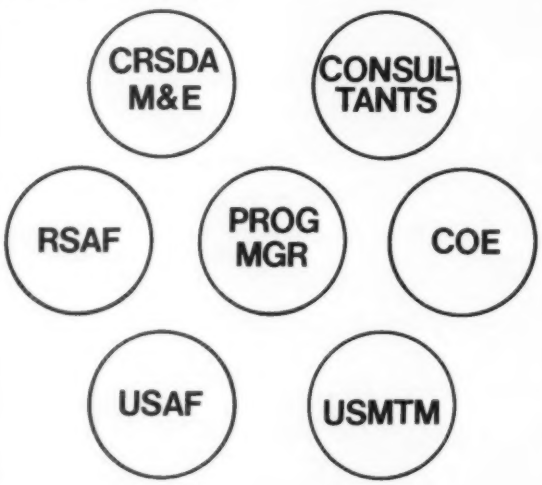
The lessons learned from Peace Hawk V provided the basis for many management actions leading to the successful launch of the Peace Sun II (F-15) Facility Construction Program. These lessons included the need for:

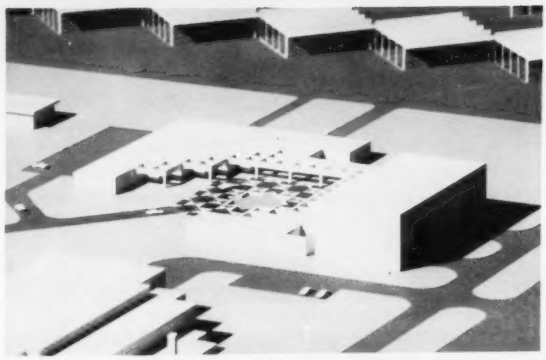
- **A central design center;**
- **Fewer layers of contractors;**
- **Single responsibility for quality design and construction;**
- **Early establishment of design criteria;**
- **Improved RSAF/US Air Force coordination; and**
- **US Air Force/RSAF/Corps of Engineers collocation.**

Headquarters AFLC/Engineering and Services approached the new challenge with experienced personnel from Peace Hawk V. The A-E selection process involved reviewing the capability of 43 firms or joint ventures. This list was narrowed to five firms, each of which it was felt could easily perform the task at hand. The five firms were each called in for a presentation of how they would handle a $600 million construction package in Saudi Arabia. Each firm presented its management approach. All proved to be interesting and led to a total rewrite of the Statement of Work which would allow each firm to perform at its best. The joint venture of Caudill, Rowlett, Scott Design Associates and Metcalf and Eddy was finally selected for direct A-E support, with McDonnell Douglas (MCAIR) and Northrop Corporation as special consultants. Constructors Managers and the Corps of Engineers jointly performed market analysis, design reviews, cost estimates and constructability reviews.

While the A-E selection was being finalized, a joint MCAIR-US Air Force team completed an in-country survey determining the requirements for facility construction and modification to support F-5Es and the F-15. Proposed facility line items, project descriptions and facility criteria books were established and presented to the RSAF.

Members of the Team responsible for the massive construction program work under the guidance of Air Force Logistics Command Engineering and Services, the program manager.



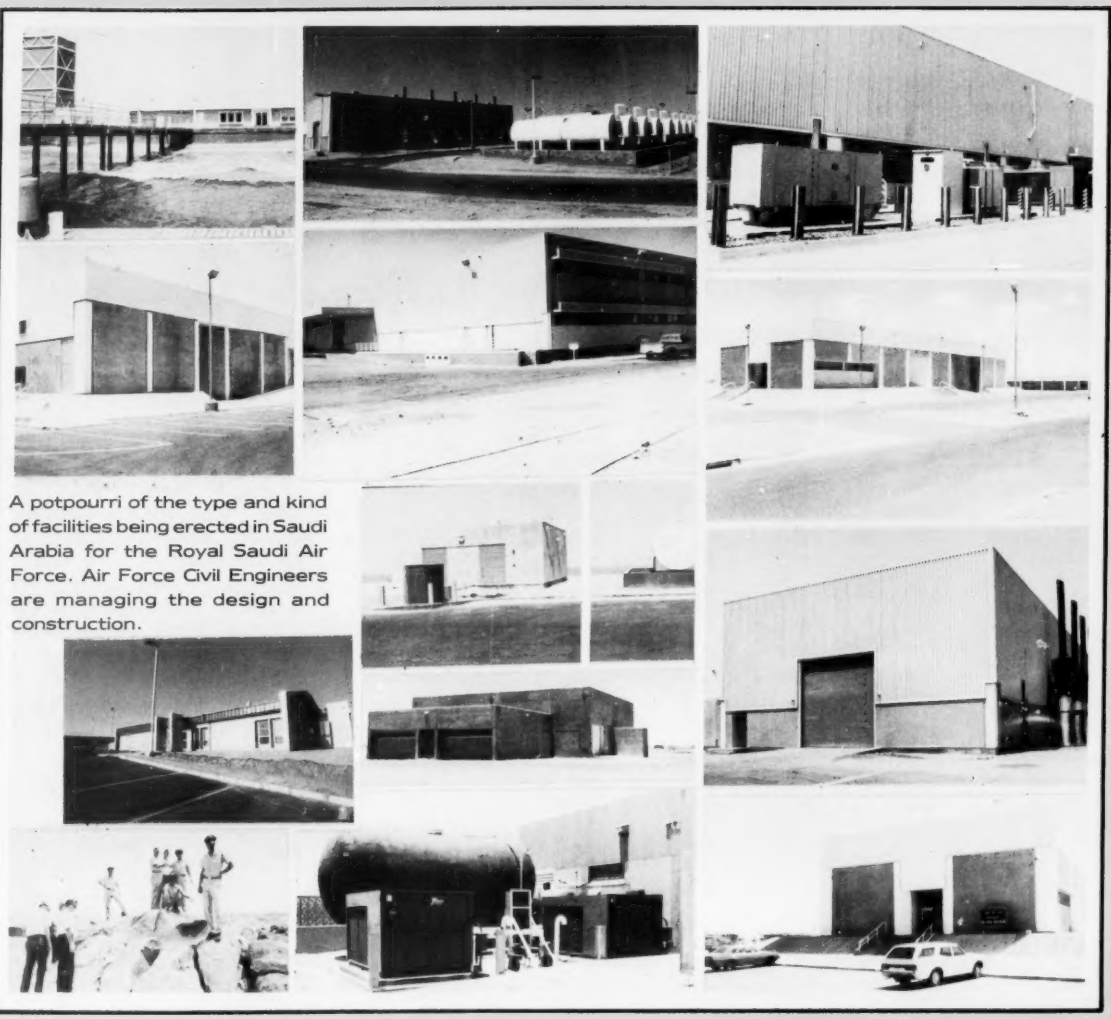


Models, such as this F-15 squadron operations and flight simulator facility, graphically represent the final product.

These inputs served as the basic documents for A-E programming and detailed site surveys. The initial site trip dissected the requirements, coordinated the F-5 requirements and briefed the RSAF of program problems to be solved in concept designs. The team spent four months assuring that program data were correct, that the concept designs represented were solutions to the unique aircraft integration program, and that the desires of the RSAF were met.

Shortly after the A-E selection and initial trips to existing air bases and the proposed in-country site, steering groups were formed which included the following surrogate commands: Air Force Systems Command (Aeronautical Systems Division F-15 Special Project Office (SPO), Simulator SPO and F-5 SPO); Air Training Command; Tactical Air Command; North Atlantic Communication Region; Headquarters AFLC staff/line agencies; United States Military Training Mission; the Corps of Engineers; the A-E, including Constructors Managers; the manufacturing agencies, MCAIR, Northrop, Lockheed, Singer Link, Goodyear, Federal Aviation Agency, Bell Helicopter, Pratt and Whitney, and General Electric; and, of course, the RSAF. It was not important the entire group meet at any one time, but it was paramount that each player knew his role and the importance his decision could have on the success of the entire expedited design and construction effort.

The RSAF has responded well with the team approach by dedicating key engineering personnel to be collocated in the central design center, making sure problems are staffed early, and bringing their command expertise to numerous design concept reviews on the drawing boards at the design center and at formal presentations in Saudi Arabia. Each session has molded the team approach into a unique program management relationship. All players feel the pressure of responsibility to achieve the goal: "the best aircraft maintenance



A potpourri of the type and kind of facilities being erected in Saudi Arabia for the Royal Saudi Air Force. Air Force Civil Engineers are managing the design and construction.

and management facilities in the world, supporting RSAF operational readiness."

The Air Force should be proud of this Government-to-Government role we find ourselves in, and realize it is only with the unique opportunities to serve hand-in-hand with our friends that we can hope to maintain peace in the world. The Foreign Military Sales construction programs are a challenge to our management and our communicative skills as well as our engineering excellence. E&S

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McCLELLAN ENERGY SHOWCASE EAST

by Major George Kastanos

Air Force Logistics Command has developed a concept which will determine the usefulness of advanced energy technologies and conservation measures. The concept is in line with DOD and DOE efforts to help solve the nation's energy problems.

The Department of Defense (DOD) and the Department of Energy (DOE) agreed over two years ago that joint efforts had to be made to help solve the nation's energy problems. To this end, the two departments entered into a Memorandum of Understanding (MOU) for across-the-board actions. The MOU, signed on 19 October 1978, established two basic goals:

- **To improve energy efficiency and availability within DOD, and**
- **To use DOD and DOE expertise and facilities to complete projects of mutual interest.**

Furthermore, the MOU stated that cooperative energy activities undertaken between DOD and DOE should be designed to: enhance national security; reduce United States dependence on foreign energy supplies; ensure that we can use renewable domestic energy resources; and promote energy conservation efforts.

The Energy Showcase Initiative at McClellan AFB, California is the result of joint actions under the MOU and is intended to produce a technical display of applications of advanced energy resource management procedures and selected new energy supply and conservation measures. The goal of the initiative is both to inform and to stimulate interest in these energy initiative areas by industry, government, researchers, Congress and the public.

A primary showcase base has been selected for each military service located near centers of population in each of the Western, Eastern and Central regions of the United States. In addition to being selected for geographical separation and ready access to the installation by the target population, the following criteria were also considered:

- **Top level support of the installation and intermediate commanders.**
- **Pattern of success for new or innovative activities.**
- **Compatible base mission.**
- **Compatible physical layout.**
- **Minimum security restrictions.**

As a result, DOD chose McClellan AFB as the Air Force's energy showcase base. The Army showcase is the Red River Army Depot and Lone Star Army Ammunition Plant complex at Texarkana, Texas. The Navy showcase base is the Sewells Point complex at Norfolk, Virginia.

Objectives and Scope

The Air Force Logistics Command (AFLC) program includes use of a full range of energy conservation technology and alternate energy sources, an estimate of the benefits accrued by DOE and DOD, the management organization necessary to accomplish the program fully, and its estimated costs.

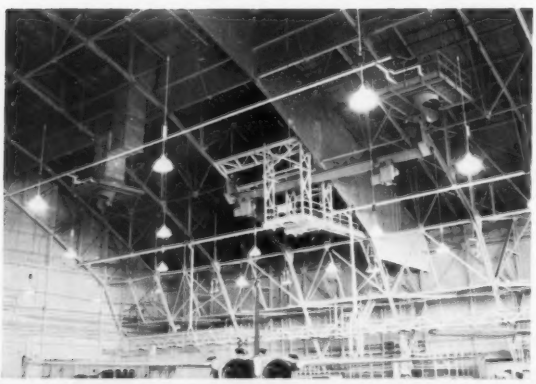
One specific objective was to identify and recommend those technologies and/or energy source uses that McClellan AFB can fully apply to satisfy its energy needs. The various requirements AFLC civil engineers considered were logistics, overall possible mission impact, operation/maintenance implications and management procedures for long-term use. In addition, engineers looked into the existing base modernization and expansion plans, force readiness, the current and future manning situation and command and base level management abilities in developing the AFLC concept plan to assure that we would recommend no technology or system that would adversely affect McClellan AFB.

In short, this Initiative's plan is designed to fit as perfectly as possible into the developing long-range energy use plan of the base while providing a demonstration avenue which can stimulate technology growth and give operational visibility to industry, government, the R&D community and the general public.

Current Energy Use

In determining the applicable energy technologies and/or sources, McClellan AFB had to establish its current pattern of energy use. This approach required us to review historical energy consumption data, with emphasis on the data most recently available, to determine the current consumption levels. Energy consumption by month for Fiscal Year (FY) 1977 was analyzed along with heating and cooling-degree-day data for this period. These figures represented only the amount of energy crossing the boundaries of the base and did not consider energy conversion processes outside or within the boundary. For example, the electrical energy data represented energy purchased from the

A solar application is being considered for the industrial paint hangar, the largest single energy consumer on McClellan AFB.



Photovoltaic energy will provide cathodic protection for water towers and utility systems.

Aircraft skin temperatures must be 70 degrees F for maintenance purposes. This results in temperatures of 140 degrees F in bi-bay hangars. Recirculation of that air will save substantial amounts of energy.

local electric utilities and did not include any power plant fuel-to-electricity conversion efficiency or the transmission losses within the base distribution system.

In addition to total levels of energy consumption, McClellan AFB estimated the energy flow within the base boundaries to indicate where and how it was using energy. Important factors in evaluating the applicability of possible alternative energy sources were knowledge of the annual and monthly energy consumption patterns, determination of the peak energy demands as well as the hourly and daily variation in energy requirements. This data allowed us to select the energy technology and source that were most effective for each use.

Future Energy Use

The energy requirements for McClellan AFB were projected to the year 2000 to assess the impact of full use of both energy conservation technologies and alternate energy sources.

The projection was developed assuming that all applicable energy technologies and sources are used to the fullest possible extent, that fuel availability is adequate for future growth, and that current energy usage patterns continue. As a result of this projection, energy use can be expected to decrease by 20 percent by FY 1985 as compared to FY 1975 based on a BTU/square foot comparison. Achieving the projection will require additional funding for energy saving construction/facility retrofit projects according to the developing long-term energy plan for McClellan AFB. The objective of the long-term plan is to be self-sufficient in industrial energy by the year 2000.

Technology Recommendations

Once AFLC established energy consumption patterns, we formulated a long-range energy plan designed to minimize energy consumption. We outlined areas of interest to DOE for demonstrations and compared them to required areas detailed in the plan. The technologies/methods chosen for implementation were where the interests of DOE coincided with McClellan's requirements. They fall into two broad areas: Energy Conservation and Alternate Energy Sources.

Energy Conservation

Under utilities centralization, we are examining two categories:

- **Centralizing a large number of facilities (total base), and**
- **Centralizing for individual facilities (single buildings).**

The two are not mutually exclusive for a large, diversified base and can be complementary, if developed correctly. Based on evaluation of the many possible combinations of both central and distributed utilities systems, the following offered the best mix of technology demonstrations and reduced energy consumption:

1. Centralize all base-supplied utilities (thermal energy, chilled water and compressed air) into one or more plants as appropriate. The thermal energy generation plant shall also be configured to produce some electricity by operating in a cogeneration mode. The combustion system best suited for this type of plant is an atmospheric fluidized bed boiler/steam turbine configuration.

2. Provide individual on-site total energy systems for certain critical facilities to achieve maximum electricity/thermal energy use ratio of the base. These systems will be implemented sequentially at a 200kw level to allow comparison data to be gathered over the entire lifetime of each system. The types of advanced technologies to be used are: phospheric acid fuel cell; multifuel Stirling engine; and a multifuel, long-life diesel engine.

In the Energy Monitoring and Control System (EMCS) area, we anticipate extending the existing EMCSs to include all energy-intensive base facilities and tying them into both HVAC systems and appropriate industrial processes/equipment. Additionally, we will be using the EMCS network to integrate, control and

The existing EMCS will be expanded to include all initiatives and other base facilities. The hard copy data will provide performance information for validation and analyzation purposes.

Four off-base Capehart housing units will receive different solar applications for domestic hot water and space heating.

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monitor the technology demonstrations. Meters for each type of energy used will be installed in every facility involved in the Showcase program to record and validate energy savings/use. Weather data and security alarms will also be incorporated into the network. This over-all program will create a thoroughly integrated, energy-consuming industrial complex capable of being monitored and controlled from one central location.

The facility energy use optimization covers all energy conservation/reuse technologies concerning the facility envelope, HVAC systems, and industrial processes within the facility. Each type of facility examined will have its minimum possible energy use determined by a systems analysis. The analysis will consider all possible factors affecting energy use, such as microclimate, process needs, technology availability and personal comfort. The types of facilities to be examined will be a foundry, electroplating shop, high bay periodic depot maintenance hangar, final cell dock, paint hangar, automated warehouse and an administration facility. These eight major facilities comprise about 60 percent of the annual energy consumption of McClellan AFB, and we have shown that the base's energy efficiency can be increased dramatically by using available energy conservation technology and the latest design methods.

Alternate Energy Sources

The alternate energy sources applicable to McClellan AFB under the Showcase program limitations are chemical, solar radiation and wind. The chemical category includes all fossil fuels not currently in use on the base and all synthetically produced fuels. The central cogeneration plant will use coal as its primary fuel, thus reducing the base's use of natural gas and fuel oil. In addition, the various individual building total energy systems will be capable of using a variety of fuels, both naturally occurring and synthetic.

As for solar radiation, the two conversion methods applicable for McClellan AFB are photovoltaics and low temperature thermal systems. We are examining photovoltaic power systems for the cathodic protection systems on base and for a portion of the electroplating facility. For the electroplating system, we will use an actively cooled, concentrating array to both heat the solution tanks and augment the utility electric grid. With this type of dual system, we can achieve system efficiencies as great as 80 percent. The low temperature solar thermal applications were chosen to display and establish comparative data on a wide variety of technology. We expect to use both active and passive solar domestic hot water and space heating systems on eight family housing units; active solar space heating and cooling systems on dormitories; and process heating for the aircraft paint hangar. We are currently selecting specific systems.

The wind potential at McClellan AFB is limited to small power applications located on the base proper. We will use these systems to augment the central cogeneration plant.

Current Status

DOE, Headquarters US Air Force and Headquarters AFLC provided funds for an Architect-Engineer (A-E) firm to perform a feasibility study of the total, AFLC-prepared concept. The A-E is a joint venture of the firms CH2M-Hill, TRW, and Wismer and Becker. A contract was formally signed 20 August 1979, and the $972,000 study will be completed by June 1980. If the scope of the study is approved for construction, project cost could be in the $100 to $300 million range spread over several years, and joint meetings between DOD and DOE will have to determine funding responsibilities. A $1.6 million line item has been included in the FY 1981 Military Construction Program (MCP) to start this initiative, and a $16.5 million item has been identified for the FY 1982 MCP.

Summary

This article has been a brief examination of the Air Force Energy Showcase Program. The major objective of this program is to demonstrate and establish a comparative data base on many advanced energy technologies and conservation procedures. The DOD must know what to expect when it incorporates such systems into our force structure or even if such incorporation is beneficial. The program is a rational, integrated approach in line with DOD and DOE policies to determine the usefulness of advanced energy technologies and procedures. E&S

A SUPER SPECIAL PROJECT REPORT

Air Launched Cruise Missile Construction Program

While the Air Launched Cruise Missile Construction Program is not the largest of the super projects, the challenges are great. Air Force Civil Engineers will play a significant role in the development of the support facilities.

by Maj Gerald L. Robinson, Capt S.M. Tully, PE, and Capt B.E. Wilson

The Air Launched Cruise Missile (ALCM) is a strategic weapon system that will enter the inventory of the Strategic Air Command (SAC) during the early 1980s. The missile is a relatively small, long range, air-to-ground, sub-sonic, highly maneuverable vehicle capable of accurately delivering a nuclear warhead to a target by means of a self-contained guidance system.

The ALCM will be carried by modified B-52G aircraft equipped with a new Offensive Avionics System (OAS). Its use on the B-52G force will provide increased bomber targeting and routing flexibility while reducing B-52 exposure to enemy defenses. Current plans call for the procurement of approximately 3,400 ALCMs to equip each of the 151 B-52G aircraft with 20 ALCMs, eight internally on a rotary launcher and 12 externally on two jettisonable pylons. Initial equippage will be limited to the 12 externally loaded ALCM missiles with both Short Range Attack Missiles (SRAM) and gravity bombs carried internally. Starting in FY 1986, the B-52Gs will be loaded with the additional eight internal ALCMs, thereby replacing the SRAM and gravity weapons.

With the growing vulnerability of our manned bombers, the operational need for the B-52/ALCM weapon system was obvious. Two versions of the ALCM, the AGM-86B and the AGM-109 were developed by competing missile system contractors, Boeing Aerospace Corporation and General Dynamics/Convair Corporation, respectively. This competition, during full scale engineering development, included a fly-off between the two missiles. This live launch competition began in July 1979 and was concluded in February 1980. In late March, the Secretary of the Air Force announced that Boeing was the winner of the competition and would be the Air Force's prime contractor, subject to a production decision expected shortly.

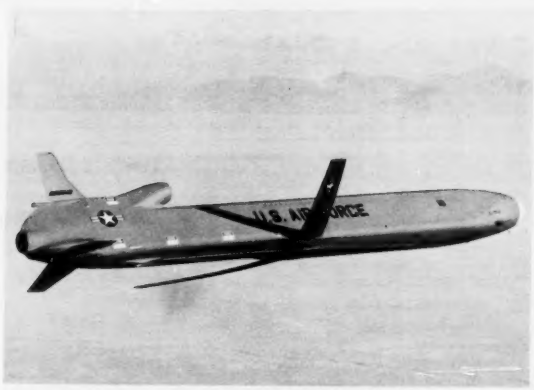
Each missile contractor was required to provide facility design criteria to Air Force Civil Engineers. Since the two companies were engaged in competition, they were not able to provide a coordinated set of facility requirements. However, as the two systems use a common guidance system and engine, and the missiles are approximately the same size, the facility requirements are similar. Also, Boeing Military Aircraft Company (BMAC) was contracted to provide long lead time items of common support equipment such as automatic test equipment for ALCM and SRAM and missile handling equipment. These support equipment items have been prime drivers in determining basic facility requirements.

Since selection of the winning contractor did not occur until the end of March 1980 and the required completion date for facilities at Griffiss AFB, New York, the first operational base, is March 1981, Air Force Civil Engineers could not wait for source selection to determine the characteristics of the ALCM support facilities. In order to provide timely support for the ALCM/OAS program, Civil Engineers from Aeronautical Systems Division (ASD) and SAC worked with engineers from both competing contractors and BMAC to develop consolidated Air Force designs capable of supporting either weapon system.

The focal point for support of the ALCM and SRAM weapons system will be the integrated maintenance facility (IMF). This facility will provide the space, environment, equipment and utilities necessary for test and organizational level maintenance of the ALCM and SRAM missiles and components. Individual missiles will be maintained on test stands while entire clips (loaded launchers and pylons) will be tested and maintained from support frames. Checkout, fault isolation, removal and replacement of engines, missile loading/unloading on clips, and clip testing of loaded/unloaded pylons and launchers will be accomplished in this vital facility.

The IMF is a 32,400 square foot structure consisting of a high-roofed missile maintenance and testing area and a low-roofed ad-

The General Dynamics/Convair Corporation ALCM.



The Boeing Aerospace Corporation ALCM.

ministration area. Except for a frangible wall located in the SRAM test area, all exterior walls will be cast-in-place reinforced concrete to meet security requirements. The administration area will be segregated from the maintenance area by a concrete, blast-resistant shelter. Exterior faces of concrete walls will be covered with rigid insulation and pre-finished sheet metal siding. The frangible wall construction in the SRAM area is provided to release over pressure that would occur during an inadvertent firing of the SRAM booster while under test. The frangible wall construction will consist of light steel framing covered with pre-finished sheet metal siding on the exterior and a pre-finished sheet metal lining panel on the interior. The blast wall protecting the administration area will be cast-in-place, reinforced concrete.

Maintenance areas of the IMF where the ALCM will be present will be separated from the other maintenance areas with vapor proof walls to minimize the hazards associated with working on and around fueled air vehicles. Areas in which fuel lines will be disassembled as part of routine maintenance will have two-hour fire rated walls. The presense of fuel, high explosives and nuclear warheads increases the potential fire hazard in this facility. Therefore, an Aqueous Film Forming Foam (AFFF) sprinkler system will be installed in all ALCM maintenance areas. Halon 1301 systems will protect the environmentally-controlled automatic test set area while a standard water sprinkler system will protect the mechanical room and administration area.

The ALCM handling equipment, currently designated the MHU-173/E munitions lift trailer, is far larger than that presently used for SRAM or gravity weapons. The entire tow tractor, trailer, pylon assembly is roughly 65 feet long, 11 feet high, and 13 feet wide and will have a turning radius of 50 feet. Due to these characteristics, a drive through bay with 18-foot-wide by 12-foot-high doors will be provided in the high bay portion of the IMF. In addition to size, the weight and foot print of this assembly creates a 21,000-pound equivalent single wheel load (ESWL). In order to support this load, the floor in the IMF high bay will be 12-inch concrete slab-on-grade.

To facilitate missile handling, a three-ton nuclear certified monorail

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MAJOR ROBINSON *is a Program Manager in the Programs Division, Directorate of Engineering and Services, Headquarters US Air Force. He received his bachelor of science degree in civil engineering from the University of Maine.*

CAPTAIN TULLY *is a Weapons System Civil Engineering Requirements Officer assigned to Headquarters Strategic Air Command, Offutt AFB, Nebraska. He received his bachelor's degree in electrical engineering from the University of Wyoming. He is a registered Professional Engineer in Iowa.*

system will be installed throughout the IMF for missile transfer. All ALCM missile maintenance, test and loading/unloading areas will be interconnected by this monorail system. In hazardous areas, the monorail trolly/hoist assemblies will be mechanically operated while the remainder will be electrically operated.

Although the IMF can be considered the heart of the maintenance complex, several other facilities are required for proper maintenance and storage of the ALCM. One such facility is the munition storage igloo. The ALCM loaded pylons will be stored in these igloos in an all up round (warhead and missile mated) configuration. Because of the requirement to store the loaded ALCMs on pylons and the large size of the munitions lift trailer, a new standard in storage igloos had to be established. The interior dimensions of the new ALCM igloos will be 120 feet long by 40 feet wide with two drive through storage bays each with two 18-foot-wide by 13.5-foot-high doors. These igloos will be of cast-in-place, reinforced concrete arch construction with the head wall and door capable of withstanding a momentary 100 psi overpressure. Each igloo will be capable of storing four pylons (24 ALCM). Due to the size and turning radius of the ALCM trailers, there will be a 100-foot-wide concrete ramp on both sides of the storage igloos. This ramp and the igloo floors are both designed to support the 21,000-pound equivalent single wheel loads associated with a fully loaded ALCM trailer.

The ALCM Unarmed Weapons Storage Facility provides the space, environment, equipment and utilities necessary for shipping and receiving of missiles and components as well as the storage of unarmed, single missiles. This facility will be a rectangular, steel frame structure with pre-finished sheet metal panel walls and roof consisting of a total floor area of approximately 8,900 square feet. A drive through area with 18-foot-wide by 14-foot-high doors capable of accommodating both the ALCM lift trailer and commercial trucks will be constructed and serviced by a five-ton bridge crane to facilitate loading/unloading of missiles, pylons and launchers. Three storage bays will be provided to accommodate up to 60 unarmed ALCMs. A monorail system will extend into each storage bay allowing the hoist trolley on the bridge crane to transfer to and from each monorail spur. This insures maximum flexibility in storage and retrieval of individually identified missiles. Due to the value of the assets stored in this area and the activity associated with the shipping/receiving/storage functions, a Carbon Dioxide Fire Suppression System will be installed. This system was selected because the facility is not continuously occupied and is unheated.

The Warhead Maintenance & Inspection (M&I) facility will serve as a shipping and receiving point for the ALCM nuclear warheads. It will be used to perform current maintenance activities for existing SRAM warheads and gravity weapons and provide for the inspection of ALCM warheads and replacement of limited life components. The existing SRAM IMF could not have been economically modified to serve as an ALCM IMF due to the small size and the special ALCM maintenance requirements discussed earlier. Since the SRAM IMF satisfies the safety and security requirements needed in a warhead M&I Shop, it is being converted for use as an ALCM/SRAM/gravity weapon M&I Facility requiring only minor modifications.

As pointed out earlier, all of the facilities play a vital role in the successful accomplishment of the ALCM mission. Some of the required facilities not mentioned earlier include the Ground Support Equipment Maintenance Facility, which provides the necessary structure for maintaining the oversized ALCM handling equipment and the Mission Planning Facility which accommodates the ALCM mission data preparation system.

After design review of the ALCM munitions lift trailer in early 1979, it was determined that due to the foot print of the trailer, the load bearing areas of the front two wheels overlapped. The Army Corps of Engineers Waterways Experiment Station in Vicksburg, Mississippi analyzed the characteristics of the foot print and determined that the two front wheels would be equivalent to a single wheel loading of 21,000 pounds. Based upon this knowledge, convoy routes and facility access roads at the operational bases were surveyed to determine their adequacy. In most cases, the existing roads would have had a limited life expectancy of one to three years. Therefore, all primary convoy routes and portions

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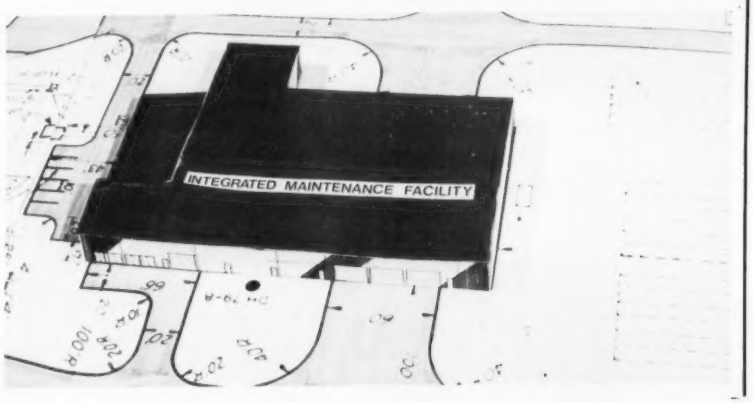

CESMETips

The Air Force Civil Engineering and Services Management Evaluation Team (CESMET) reviews, evaluates and assists Base Civil Engineers and Services functional areas in accomplishing their mission in the most effective and efficient manner. As the result of the Team's visit to bases worldwide, the team learns of many good (and some not so good) operations. This new department is designed to pass along to base organizations new ideas of ways to do the job better with less resources.

CESMET presents Certificates of Outstanding Achievement to people it sees at bases who are doing absolutely "top-notch" work. Here is a list of the recipients for the past six months:

OFFICE	BASE
CE Shops	Fairchild AFB
Fire Prot. Tech. Svs.	Fairchild AFB
BCE Funds Mgmt.	Griffiss AFB

FIRE PROTECTION An effective method of training fire fighters in aircrew egress tactics is employed at Charleston AFB. C-141 aircrews flying local training missions are given scenario cards by Base Operations. The crew declares a simulated in-flight emergency and the fire department responds accordingly, a realistic exercise for fire fighters and aircrews. This effort requires close coordination between the Operations staff and Fire Department training personnel. For details, call Chief Tilman, AUTOVON 583-3326.

BUDGET The Funds Management Office at Griffiss AFB was awarded a CESMET Certificate of Outstanding Achievement recently. It was recognized for its total involvement in financial operations and its contribution to the success of civil engineering operations. The office has the most comprehensive and detailed Financial Analysis Book ever seen. It includes all facets of the BCE Financial responsibilities; historical cost data; several analyses and a tracking system for all current year changes in the BCE program--an excellent was to keep financial data at the boss's fingertips. For details, call Ms Betty Wittman, AUTOVON 587-2311.

SUPPLY Decentralized civil engineering bench stocks generally do not have as high a bench stock availability rate as centralized ones. The Material Control bench stock monitor's management expertise can be used to keep items on the shelf and keep the availability rate up when the bench stock is under centralized control. At a base recently visited, the Fire Protection Branch bench stock was centralized and the availability rate ran between 94 and 99%. After decentralization in August 1979, the rate dropped below 80% for September and October. The bottom line--only decentralize bench stocks when absolutely necessary.

CONTRACTING CESMET often sees misunderstanding and uncertainty concerning the use of new performance-type statements of work for service contracts. Several years ago, the Air Force Service Contract Advisory Group was formed to manage the preparation and implementation of performance oriented statements of work. Several performance specifications have already been issued for mandatory use, others are being tested at specific bases, and a few are in fianl draft, awaiting test and evaluation. AFR 400-28, Vol I, contains the new guidance--get it and read it. Questions and comments concerning performance oriented statements of work should be addressed to the various command OPRs through you own major command AFSCAG representative. Next time, we will give you a list of all performance oriented statements of work and their current status.

TRANSPORTATION All Air Force vehicles are assigned a replacement code based on age and mileage/hours. Codes A through J represent those vehicles which qualify for immediate replacement. Approximately 28% of all vehicles fall into codes A-J. Based on observations, most civil engineering fleets are average in terms of need for replacement. The Vehicle Master List (PCN 310023, Part B) can give you information about your fleet. Ask your vehicle manager to get the statistics for you from Transportation.

SERVICES Commanders have a much greater knowledge of the Services organization at bases where the Services officer is providing regularly scheduled Commander's Update Briefings. A well organizaed briefing is also a valuable aid to the Services officer in managing daily activities. The end result--better management and improved customer service. CESMET recently published a Commander's Services Update Briefing Brochure which is now being distributed to all commands. Contact your command Services office if you don't have a copy.

CIVIL ENGINEERING Some bases are doing well and others not so well in meeting customer commitments. Here are some things that are being done by bases to keep on top of this problem"

1. Continually briefing overage work at the BCE status briefing. In addition to briefing total numbers, some bases brief, by job order number, a few of the oldest job orders/work orders in the system.

2. Monitoring how long it takes to approve work, to plan work and to fill bills of materials for job and work orders.

3. Reviewing the In-Service Work Plan to see how many insertions are taking place (internally or externally initiated), how many carryovers are being experienced and how many jobs are starting with materials not complete.

4. Analyzing the weekly work schedule with respect to unscheduled annual leave, insertions, shop interface problems, working over-scheduled rather than scheduled work and large variances between estimated manhours for shop loaded job orders and actual hours expended, all of which can result in a low work schedule success rate.

These are not all the items which bases are doing to better meet customer commitments; however, they do contribute considerably. The key to meeting customer commitments is keeping the work visible for management to monitor.

Two major construction programs which represent one of the largest military construction efforts in the history of U.S. Forces' in the Far East were recently completed. Air Force Civil Engineers managed these programs which totaled $277 million. It's an example of Air Force Civil Engineers

Demonstrating Professional Capabilities

by Capt Barry Kelly

Two major programs which together represent one of the largest military construction efforts in the history of US forces' presence in the Far East were completed at Yokota AB, Japan recently. These programs were managed exclusively by Air Force Civil Engineers and consisted of 3,700,000 square feet of building space at a total cost of $277 million. In comparison, the Japan Facilities Adjustment Program, which began in 1972 as a result of Okinawa's reversion to Japanese control, will cost $10 million less at its completion in 1981. The Grant Heights/Green Part (GH/GP) and Kanto Plain Consolidation Program (KPCP) came into existence as a result of a joint effort on the part of the Japanese and US Governments to consolidate Air Force activities from nine installations scattered throughout the Tokyo Metropolitan Area, or Kanto Plain, to Yokota AB. The goal was to accomplish the same mission at a significantly reduced cost by operating fewer base exchanges, commissaries, theaters, runways and utility systems. The return of valuable real estate to the Japanese Government benefited both parties concerned.

End Products for Yokota Customers

In the fall of 1971, the first of the two packages involved the release of the GH/GP installations in exchange for 1,050 family housing units and related support facilities which were to be constructed at Yokota AB. The housing units consisted of three and four bedroom, two-and-one half bath garden apartment units featuring 1,600 square feet of living space. Five tower apartment buildings housing 70 families each were also included in the program. Each apartment in these nine-story buildings was designed and oriented to maximize entry of natural sunlight and ventilation. An "X" configuration was chosen in order to afford each apartment a view of the neighboring city or Mount Fuji. Passenger and cargo elevators were included and a wing of the first floor of each building was dedicated to social and recreation rooms.

During the design phase, concern was expressed about occupant egress in the event of an emergency such as a fire or an earthquake. In response to this concern the buildings were designed with smoke-proof stair towers, accessible directly from each apartment, and which exit to the outside at ground level. These buildings were also engineered using the very latest techniques in design to withstand the severe seismic forces and typhoon conditions experienced in Japan.

A partial list of other facilities constructed under GH/GP program includes a telephone exchange building, an elementary school and a high school, utility systems and plants, theaters, officers' quarters, outdoor recreation facilities, chapels and roads. The new commissary constructed under this program was the recipient of the Mendel L. Rivers award in 1976 and 1978 for being the best single store in the Air Force in worldwide competition.

The Base Civil Engineering complex was constructed in a central location and features convenient access for customers and minimal travel time for the work force. Space limitations required that two compounds be constructed: one, for pavements and grounds, sanitation, electrical, power production, and housing work areas, and the other, a shared compound for structural and mechanical shops, and material control. Each shop has a work area with the latest safety and fire protection systems and modern environmental control devices. Each shop's interior work area is adjacent to its exterior work area and vehicle storage area with direct access between each. Material control facilities surround the shop areas for a close relationship to material storage and for screening of work areas from the public. All storage areas are enclosed or under cover with proper circulation space and equipment storage to minimize damage during material handling and to make acccountability easier.

The one building which is not new has been renovated under the in-service work plan into a semi-open office area with the use of both exterior and interior graphics to direct customers to the customer service unit and other office functions. The construction of new

A variety of pastel colors was selected to enliven nondescript buildings and spaces.

The "X" configuration of the high rise towers was chosen to afford each apartment with a view of the city or Mt Fuji.

facilities and the renovation of the old facility have contributed to the pride held by each person working within the 475th Civil Engineering Squadron. The pleasant working environment and the proper location of functions within the organization have made Base Civil Engineering better organized, more efficient and, thus, more responsive to customers during normal operations and contingencies.

A follow-on program known as the Kanto Plain Consolidation Program (KPCP) exceeded the $103 million GH/GP Program in magnitude and cost; it further expanded Yokota's family housing with the addition of three more nine-story tower apartment buildings, bachelor enlisted housing, officer's quarters, and support facilities. By the time the financial closeout of the KPCP occurred in the spring of 1978, Yokota AB had received a total of 301 new facilities of various descriptions. Also, many of the older buildings which were to remain after the new construction was completed were upgraded through contract and in-house programs in conjunction with the Japanese funded construction. This allowed Yokota AB to take advantage of a unique opportunity to upgrade the entire base in a relatively short period.

and electrical equipment space, continuous environmental conditioning, and an uninterruptable broadcast power system.

In order to maximize use of the programmed square footage, the major pieces of heating, ventilating, and air conditioning were mounted vertically in a room which extends from the ground level up through the second level. By mounting the equipment vertically, one third the amount of floor space was used than would have been required if the equipment was floor mounted horizontally. The equipment is mounted in four layers with access doors built along the upper and lower sides of the exterior walls. Thus, cranes can move a heavy piece of equipment in and out of the mechanical room without disturbing the remaining equipment.

A triple system of converters and generator-charged batteries was designed into the building to insure an uninterrupted power source for illumination and electronic equipment. Since air conditioning is needed at all times, a backup source was also provided. In the event of a commercial power failure, a generator to power fire pumps located about 200 feet away in another building will automatically supply electricity to the mechanical system in the studio building. The only time a complete

Each BCE shop has a work area with the latest safety and fire protection system.

Bold graphics were used to direct customers to servicing units and other functions.

Approximately 120,000 square feet of office space was remodeled to meet the functional needs of agencies to be moved to Yokota AB. Reprioritizing identified work in favor of facilities designated for use by these agencies helped to minimize periods of disruption to their activities, particularly since they would have already suffered inconveniences resulting from the consolidation process. Also, the exteriors of buildings were treated with various pastel colors and architectural graphics in a successful effort to emphasize key buildings, provide directional signing and, in general, add interest and enliven nondescript buildings and spaces.

Another example of the innovative design efforts at Yokota AB is the Far East Network Studio which was designated specifically for the broadcasting mission. The building houses recording rooms, broadcasting rooms, a production studio, administrative areas and engineering support facilities. The design program included provisions for large amounts of mechanical

interruption of power to the air conditioning units might take place would be in the case of a major fire occurring on base when the generator/battery system was supplying power to the mechanical system. Should both occur at the same time, the fire would place an automatic demand on the pumps, and the generators would operate the pumps instead of the air conditioning equipment.

The roof of the building supports the shortwave antennas. These antennas are low-profile and designed mainly for ground use. The lightweight concrete roof deck had to be reinforced and shielded before the antennas were installed. The roof surface is electronically the counter plan for the antennas. The building itself is of rigid-frame reinforced concrete construction with a glazed tile finish. The total cost for construction and furnishings was $4,023,000.

Yokota AB is the only Air Force installation which has many tower apartment buildings. (Langley AFB also has

a high-rise). This presented some unique maintenance problems. The base's Civil Engineering Squadron found itself faced with a significant increase in facilities to maintain with no increase in manpower. Eight of the towers particularly posed a problem with their increased workload contribution in the mechanical and electrical building systems maintenance area. It was decided to establish a contractor operated mini-BCE operation geared to handle the maintenance workload of the tower apartment buildings and thereby reduce the shop workload. The contractor's 24 hour service call operation is physically located in the tower apartment complex for customers. Maintenance work is scheduled from computerized recurring maintenance programs, occupants' telephone service requests, and apartment turn-around maintenance job orders. Contract management monitors the contractor's performance.

The chapel was one of the facilities constructed under the GH/GP program.

Air Base Planning

During both construction programs, in-house capabilities were used to orchestrate a tremendous engineering task at a cost of $1.2 million (.43 percent of the programmed amount) for criteria development, design development and construction surveillance. Once a government-to-government agreement had been reached on the overall scope of the programs, technical design panels of the Air Force and Japanese engineers were tasked with developing preliminary designs, developing and coordinating design details, and correlating construction completion dates with relocation and facility closure schedules. A special office, the Government of Japan Design Coordination/Liaison, was established at the base level to act as the liaison between the base's using agency and Japanese engineers and government officials. By the close of the two programs, five percent of the base's facilities had been completely replaced and three percent had been extensively modified. A carefully established interface among Air Force Civil Engineers, using agencies, and Japanese engineers and government representatives was the key to the success of both programs.

Future Programs

The ball hasn't stopped rolling yet for Yokota AB. A newly implemented facilities improvement program will mean an estimated $60 million worth of additional tower and garden apartment buildings, replacement of bachelor enlisted housing and support facilities. Construction will begin in the spring of 1980. In addition, construction is already under way to widen the Japanese National Highway #16 bordering the western edge of the base, which also involves an estimated $20 million of on-base construction to replace facilities which must be razed to make way for two additional traffic lanes. Again, Air Force Civil Engineers will have the opportunity to demonstrate their professional capabilities to manage large scale, multi-million dollar construction programs. E&S

Another example of the use of architectural graphics was this rendition which blended with design of the building.

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ALCM (continued)

of the access roads in the Weapons Storage Area (WSA) and equipment maintenance area were programmed and designed for upgrading, including modification of the road system to accommodate the 50-foot turning radius.

The compressed development schedule of the ALCM limited the time allowed for development of design criteria. Initial design criteria was received in the Fall of 1978 from both weapon system contractors. The Corps of Engineers, Missouri River Division, Omaha District, was selected to design the ALCM facilities at Griffiss AFB in January 1979. Since it was not possible to design ALCM facilities in accordance with the two different sets of requirements, the Omaha District engineers were unable to actually initiate their design effort until Air Force Civil Engineers from ASD and SAC had analyzed the underlying system requirements and developed a consolidated set of design criteria which would satisfy the requirements of either system. The Corps of Engineers commenced active design in May 1979. Due to the complexity of the integration effort, classification of some system elements and changes in the system requirements, the consolidated design criteria evolved over a number of months. To facilitate communications and coordination, the Omaha District determined that the design would have to be done "in-house." From May 1979 to December 1979, the Omaha District completed design of eight ALCM Support facilities at Griffiss AFB with a total project cost of $14.2 million. During this same period, the Omaha District achieved 35 percent design for ALCM facilities at the next three locations. The "in-house" effort by the Corps of Engineers enabled facility design and construction to keep pace with the compressed system development schedule.

The IMF, Storage Igloos and the Unarmed Weapons Storage Facility will be added to the Weapons Storage Area (WSA) at the operational bases. Several problems are created by the inclusion of these new facilities in the WSA. Each new facility must comply with explosive safety requirements, which specify necessary distances between facilities based upon the quantity of explosives present in these facilities and the purpose of nature of the facility. In many cases, these distance requirements have necessitated the expansion of the WSA with a similar expansion of all relevant security systems.

A more difficult problem involved the security requirement created by the presence of contractor personnel working within the confines of the WSA. To enter the WSA, each worker must be searched and each vehicle inspected since there is only a single entry point. To process a large number of contractor personnel would involve hours of lost time every day. It was estimated that the construction of ALCM facilities using this procedure would add as much as $5,000,000 to the cost of facilities at each operational base. To avoid this cost, the ALCM construction will be accomplished by the construction of temporary perimeter fences which place the construction sites at most major facilities outside the WSA. When construction activity is not in progress, the WSA perimeter is restored to its original boundary by closing barricaded openings at the permanent fence and opening similar barricades in the temporary fence system. Use of this procedure requires close coordination and detailed construction phasing to insure that WSA security is not violated and construction activity is not hindered.

Construction phasing is further complicated by the requirement to continue the existing B-52/SRAM mission during the construction of ALCM facilities. The modification of the SRAM IMF cannot take place until the SRAM maintenance functions have been transferred to the new ALCM IMF. This requires that the ALCM IMF be completed early enough to allow sufficient time for SRAM IMF modification prior to the nuclear security inspection which will precede the delivery of nuclear weapons to the unit. Any breakdown in phasing could jeopardize the initial operational capability (IOC) at each of the bases.

It is obvious that several problems have already been encountered and solutions found even though construction at Griffiss AFB has yet to commence. When construction of the total ALCM facilities package is complete, the Air Force will have spent some $225 million on facilities alone. This does not include the $5 billion spent on research, development, test and evaluation and procurement. While ALCM is not the largest of the super projects, the engineering challenges are great and the rewards for success even greater. Civil Engineers have played a significant role in the development of ALCM support facilities and can take pride in their contributions. E&S

THE BEST OF YOUR TALENTS AND SKILLS

The articles in this issue of the **Engineering & Services Quarterly** discuss a variety of challenging and exciting job opportunities for civil engineering officers of all ranks and academic backgrounds. They represent the complexity, variety and commitment of the career field in its support of national policies and the Air Force mission — be it the M-X program, the ALCM program, or the Israeli Air Base Construction Program. The articles presented reflect programs that are all interesting and unique in their own right. They are, however, but only a portion of the overall programs and jobs that civil engineering officers perform worldwide. For example, in addition to those discussed, officers are assigned to the Air Force Weapons Laboratory at Kirtland AFB, New Mexico; to the faculties of the Air Force Academy and the AFIT's School of Civil Engineering and School of Systems and Logistics; with the Army/Navy Officer Exchange Program; to the Space Transportation System Program at Vandenberg AFB; with the Saudi Arabian Construction Program; to the various Education-with-Industry programs for energy, design, construction and environmental planning; to Military Assistance Advisory Group duty; to RED HORSE squadrons in the CONUS, England and Korea; as well as in career broadening assignments outside of the career field in ROTC detachments as Professors of Aerospace Science at civilian universities.

Equally challenging are the jobs involving the day-to-day management of our world wide base civil engineering organizations. The Base Civil Engineer and his staff are presented with a continuous series of problems to resolve, such as new mission beddowns, energy shortfalls, environmental issues, shortened design construction schedules or continuing reductions in manpower and money. Any or all of these will task to the fullest the managerial skills of any civil engineering officer.

A career in civil engineering continues to be an extremely fulfilling and rewarding experience calling upon the best of both your technical and managerial talents and skills. Most officers during a successful career will be called upon many times to employ their talents and expertise in both these areas. Obviously, therefore, there is no one career plan or series of jobs that will guarantee success and promotions. (The best insurance for success and promotion is "hard work" in your present job.) The articles in this issue serve to highlight the many and varied jobs available to you.

If you are interested in competing for any of the opportunities discussed in this issue or in previous issues of the **Quarterly,** you should convey your thoughts and interest by completing a new AF Form 90. If you have any questions about these or other assignment options, you should contact your functional representatives at PALACE BLUEPRINT. At the present time, your counterparts are Lt Col Rich Bierly, Maj Howie Underwood and Capt John Loughrey. You can contact them by calling AUTOVON 487-3451 or writing to AFMPC/MPCROS5D, Randolph AFB TX 78148.

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